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CORRELATIONS BETWEEN SENSORY AND MOTOR DISTURBANCES IN CONVERGENT SQUINT

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THE IMPORTANT factor in the production of convergent comitant squint is the primary force which turns the eyes in, i. e., the excessive convergence innervation. Little is known about this in the majority of cases of squint. In only one group is one thoroughly cognizant of the manner in which an abnormal convergence stimulus is produced and how it causes squint. This is the group in which the convergence is due to excessive hypermetropia in early childhood. There is good reason to believe, as has been pointed out in previous papers,[1] that all the other forms of squint except those which are paralytic in origin are due to a similar increase in convergence tone, however ignorant one may be as to the manner or cause of its origin.

It is the purpose of this paper to consider the sensory relationships found in all types of convergent squint and to determine the correlations between the sensory abnormalities and the motor disabilities in the hope that some light may be thrown on the source of this excessive convergence.

VARIOUS SENSORIAL RELATIONSHIPS FOUND IN SQUINT

When a subject's visual axes do not coincide, it means that he does not use his eyes together under ordinary conditions. There is one exception to this, which will be discussed later. But under appropriate test conditions it may be shown that a latent form of binocular vision exists in most cases.

Address delivered before the Ophthalmic Club, Philadelphia, Dec. 4, 1945.

From the Department of Ophthalmology, Hospital of the University of Pennsylvania.

1. Adler, F. H.: Pathologic Physiology of Convergent Strabismus: Motor Aspects of Nonaccommodational Type, Arch. Ophth. **33**:362 (May) 1945; Effect of Anoxia on Heterophoria and Its Analogy with Convergent Concomitant Squint, ibid. **34**:227 (Sept.) 1945.

Travers [2] classified binocular vision as follows:

Simultaneous Perception	
Normal Development	**Abnormal Development**
Normal correspondence	Abnormal correspondence
True fusion	
Stereoscopic vision	

Cases of squint are divided therefore into two groups, providing the patient is capable of simultaneous perception.

1. *Cases with Normal Correspondence.*—By normal correspondence is meant that the macula of the squinting eye retains the same spatial projection as the macula of the nonsquinting eye. Both have the "straight-ahead" visual direction in spite of the deviation of the squinting eye from the primary position. Normal correspondence is present, therefore, when a separate image is made to fall on each macula simultaneously, and the subject sees these two images superimposed as though they came from the same point in space as that of the image falling on the macula of the nonsquinting eye.

2. *Cases with Anomalous Correspondence.*—In these cases the macula of the squinting eye does not have the same spatial projection as the macula of the fixing eye. Instead, some part of the nasal area of the squinting eye has a common spatial projection with the macula of the fixing eye. There are three varieties of anomalous correspondence, depending on which portion of the nasal area corresponds in directional value to the fixing macula. In one type the fixing macula is associated with that part of the retina of the squinting eye on which the image customarily falls, and the projection of these two images in space is the same. This type is called harmonious. It is found infrequently, and it is the only type in which some form of binocular vision occurs under normal conditions. In the second type the macula of the fixing eye is associated with a point on the retina of the squinting eye between its macula and the point where the image customarily falls. This type is called unharmonious. The third, and most frequently found, type may be considered as a state without functional correspondence, since suppression of the nasal area of the squinting eye is so widespread that no particular area of it is found to correspond directionally with the fixing macula. This type may be considered comparable to the other types, differing only in the amount of suppression involved.

MATERIAL AND METHODS

One hundred and seventy-five private cases form the basis of this study. All the patients were examined with the synoptophore before treatment was instituted and were followed for their final sensorial results

2. Travers, T. àB.: Suppression of Vision in Squint and Its Association with Retinal Correspondence and Amblyopia, Brit. J. Ophth. **22**:577 (Oct.) 1938.

after the squint was considered to have been cured as nearly as possible, whether by operation, glasses or orthoptic training or a combination of these.

OBSERVATIONS

Table 1 shows the percentage of each type of correspondence found in our cases taken as a whole.

In table 2, the cases have been grouped according to cause of squint. The first column shows the distribution.

Paralytic Squint.—Paralysis of one or more muscles could be determined with certainty in 31 out of 172 cases, or in 18 per cent. Incomitance in the angle of squint is a definite sign of paralysis, but, according

TABLE 1.—*Percentage Incidence of Types of Correspondence in a Series of 175 Cases*

Correspondence Cases	Number	Per Cent	Number	Per Cent
Normal	64	36		
Anomalous	111	64		
(a) Harmonious			5	5
(b) Unharmonious			17	15
(c) Suppression			89	80
Total	175	100	111	100

TABLE 2.—*Distribution of Cases of Convergent Squint According to Cause*

	Series of Cases		Correspondence			
			Normal		Anomalous	
Causal Factor	Number	Per Cent	Number	Per Cent	Number	Per Cent
Paralytic	31	18	14	15	17	55
Purely accommodative	33	19	30	91	3	9
Accommodative element	35	21	7	20	28	80
Undetermined	73	42	13	18	60	82

to Chavasse, incomitance may be lost if the muscle recovers sufficiently and a comitant angle of squint remain. Chavasse [3] explained this comitant element by the fact that during the paralytic stage the antagonist of the paralyzed muscle may become shortened by contracture and remain in this shortened state. He inferred that most squints which are not accommodative belong in this category. However, comitance is not found in cases of paralysis of an ocular muscle occurring in later life, and, to our knowledge, no one has ever observed any of the children with comitant squint go through the stage of incomitance and acquire comitance as the paralyzed muscle recovered.

3. Worth, C. A.: Worth's Squint, or the Binocular Reflexes and the Treatment of Strabismus, edited by F. B. Chavasse, ed. 7, Philadelphia, The Blakiston Company, 1939.

It is true that paralysis of an ocular muscle may recover to the extent that the eye can be rotated fully in the direction of action of the paralyzed muscle, but one can always recognize the underlying weakness of this muscle by the overaction of the yoke muscle of the opposite side when the eye is turned in the direction of action of the weak muscle. This is an important sign and should always be looked for. When present, it is a sure sign that there has been a paralysis of a muscle.

Accommodative Squint.—In a total of 68 cases, or in 40 per cent of the whole series, some accommodative element was present; in less than one half of these was the squint completely accommodative. Those cases in which there is an accommodative element only belong to another group, with a different causal factor to which a sufficient hyperopia is added to give an excessive convergence tone.

The diagnosis of an accommodative squint is made on the finding of an abnormal amount of hyperopia for the age, on an increase of the squint for near vision and on the partial or complete disappearance of the squint when corrective glasses have been worn for a sufficient period of time (six months or more).

Undetermined Etiologic Factor.—There remain 73 cases, or 42 per cent of the total series, in which no etiologic factor could be found. As already mentioned, 35 of the 68 cases included in the group of accommodative squint were subsequently found to have characteristics which should include them in the group of undetermined cause. Hence, if these cases are included, it raises the total to 108, or 63 per cent of the total series.

We do not believe that anisometropia of itself causes squint. The vast majority of anisometropic patients are found to have straight eyes. Furthermore, the 15 cases (9 per cent of the total series) in which a difference of at least 1.50 D. in sphere or cylinder was found in the refractive error of the two eyes could be placed in the paralytic or the accommodative group or in the group of undetermined origin, in an even distribution, according to the criteria used for these respective groups: In 4 cases the squint was of the paralytic type; in 3, of the purely accommodative type; in 3 there was an accommodative element, and in 5 the cause was undetermined. Anisometropia has no characteristics which justify regarding it as a separate etiologic entity.

CORRESPONDENCE IN RELATION TO CAUSAL FACTOR

Paralysis of a muscle shows no tendency toward one type of correspondence. In cases of purely accommodative squint there is normal correspondence as a rule, i. e., in 90 per cent of cases. In most cases of squint with an accommodative element, i.e., in 80 per cent, there is anomalous correspondence. In this, as in other respects, they are like the cases of squint of undetermined cause.

In 82 per cent of the cases of squint of undetermined cause there was anomalous correspondence. Can one explain the anomalous correspondence in this group and in the cases with an accommodative element? In order to throw light on this question, the cases were

TABLE 3.—*Relation of Angle of Squint to Type of Correspondence*

Angle of Squint, Degrees	Correspondence					
	Normal		Anomalous		Total Cases	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
0-10.....	20	83	4	17	24	14
10-15.....	12	63	7	37	19	12
15-20.....	6	25	18	75	24	14
20-30.....	8	24	26	76	34	21
30-40.....	8	24	25	76	33	20
40-50.....	4	14	25	86	29	18

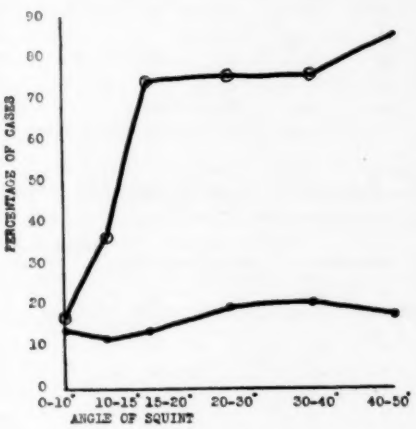

Chart 1.—Relation of angle of squint to type of correspondence. The line with hollow circles indicates the percentage of abnormal correspondence; the line with solid circles, the distribution of the total series of cases.

analyzed according to the relations of the following factors: (*a*) relation of correspondence to angle of squint, (*b*) relation of angle of squint to causal factor, (*c*) relation of correspondence to alternation, (*d*) relation of correspondence to age of incidence, (*e*) relation of correspondence to duration of squint and (*f*) relation of correspondence to amblyopia.

Relation of Angle of Squint to Correspondence.—Since the excessive convergence innervation appears to be the primary cause of squint, it would seem logical to regard the angle of squint as an index of the degree of this innervation. Does the degree of innervation as indicated by the angle of squint show any constant relation to the type of correspondence? (Table 3 and chart 1.)

Our studies show that most patients with squint of low angle had normal correspondence; the percentage of incidence of anomalous correspondence rose as the angle of squint increased. Of patients with squint of 40 to 50 degrees, 86 per cent had anomalous correspondence. The graph shows a sharp rise in the percentage incidence of anomalous correspondence with the angle of squint between 15 and 20 degrees, as against the fairly even distribution of the total number of cases throughout a range in angle of squint up to 50 degrees. The significance of this should be investigated further.

TABLE 4.—*Relation of Angle of Squint to Causal Factor*

Angle of Squint, Degrees	Paralytic		Accommodative		Accommodative Element		Undetermined	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
0-10	4	15	15	50	0	0	5	7
10-15	3	12	7	23	4	12	4	6
15-20	1	4	2	7	4	12	15	22
20-30	6	23	4	13	13	40	11	16
30-40	7	27	2	7	7	21	17	25
40-50	5	19	0	0	5	15	16	24

TABLE 5.—*Relation of Angle of Squint to Causal Factor*

Angle, Degree	Paralytic		Accommodative		Accommodative Element		Undetermined	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
0-10	4	17	15	62	0	0	5	21
10-15	3	17	7	39	4	22	4	22
15-20	1	5	2	9	4	18	15	68
20-30	6	22	4	15	13	48	4	15
30-40	7	21	2	6	7	21	17	52
40-50	5	19	0	0	5	19	16	62

Relation of Angle of Squint to Causal Factor (table 4).—The angle of squint has no relation to paralysis. On the other hand, the vast majority of purely accommodative squints were of low angle—73 per cent were of 15 degrees or under. Squints of undetermined cause showed just the opposite—only 13 per cent were of 15 degrees or under.

If one is dealing with a squint of low angle, the chances are that it is accommodative, whereas if the squint is of high angle, i. e., 40 to 50 degrees, the chances are in favor of its belonging to the group of undetermined cause (table 5).

Relation of Correspondence to Alternation.—There is a marked difference between a monocular squint, in which the person cannot fix

with the squinting eye, and an alternating squint, in which he constantly shifts from one eye to the other; but between these two extremes there is no sharp line of demarcation. Strictly speaking, in alternating squint the patient uses either eye in the primary position without any preference. In borderline squint the patient can alternate the fixing eye but shows a preference for one eye. Monocular squinters are those who habitually use only the one eye.

Eighty-three per cent of persons with alternating squint have anomalous correspondence. However, it is apparent that alternation itself is not the cause of anomalous correspondence, since monocular squinters do not have predominantly normal correspondence but are about equally

TABLE 6.—*Relation of Correspondence to Alternating Squint*

	Correspondence					
	Normal		Anomalous		Total Cases	
Type	Number	Per Cent	Number	Per Cent	Number	Per Cent
Alternating	10	17	49	83	59	34
Borderline	7	37	12	63	19	11
Monocular	47	48	50	52	97	55

TABLE 7.—*Relation of Alternating Squint to Causal Factor*

	Paralytic		Accommodative		Accommodative Element		Undetermined	
Type of Squint	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Alternating	9	16	4	7	11	18	34	59
Borderline	3	16	0	0	7	37	9	47
Monocular	18	20	28	30	17	18	30	32

divided between persons with normal and persons with anomalous correspondence (table 6).

What factors are present in alternating squint which probably predispose the patient to anomalous correspondence? Table 7 shows that most cases of alternating squint, i. e., 59 per cent, belong in the group of undetermined cause.

Patients with alternating squint have the largest angle of squint, which, as has been seen (table 3 and graph 1), predisposes to anomalous correspondence. The close tie-up between angle of squint and anomalous correspondence also explains the even distribution of types of correspondence in monocular squinters. Table 7 shows that there is no one outstanding category so far as cause of squint is concerned in the monocular class. Further, the angles of squint in cases of monocular squint are about equally distributed over the whole range of angles.

As one would expect, the borderline cases fall between alternating and monocular squint in predominance of anomalous correspondence.

Relation of Correspondence to Age of Incidence.—It is frequently difficult to determine with accuracy at what age a squint began, but in private cases the history is usually of more value. On this basis, the age of incidence in this series of cases is as follows (table 8).

In nearly all the cases the squint appeared in the first four years of life. When the cases are grouped according to the etiologic factor

TABLE 8.—*Relation of Correspondence to Age of Incidence* *

Age Incidence, Year	Number of Cases	Per Cent
Birth	53	33
1	27	17
2	24	15
3	28	17
4	21	13
5	4	2.5
6	2	1
7	3	1.5
Totals	163	100

* Cases of squint beginning at birth include those occurring up to the first year of life, and similarly with each year entry.

TABLE 9.—*Relation of Age Incidence to Cause of Squint*

	Paralytic		Accommodative		Accommodative Element		Undetermined	
Age Incidence	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Birth	12	29	4	9	2	5	24	47
Up to 1 yr	1	10	4	40	0	0	5	50
Up to 2 yr	4	14	3	10	7	24	15	52
Up to 3 yr	4	17	2	9	8	35	9	39
Up to 4 yr	4	15	4	15	10	37	9	33
Up to 5 yr	2	9	9	41	7	32	4	18
Up to 6 yr	2	22	4	44	3	34	0	0

(table 9), it appears that the majority of cases of squint beginning in the first two years belong to the group of undetermined origin. At about the second year the group with an accommodative element shows an increase, and at about the fourth year the group of purely accommodative squint takes the lead. This is interesting in that it shows a further relationship of the group with an accommodative element to both the group of squint of undetermined cause and the group of accommodative squint.

If one examines the figures which relate correspondence to age of incidence, one notes a tendency of anomalous correspondence to be

predominant in cases of squint which began in the first four years of life. In the cases in which it appeared in the fourth or fifth year normal correspondence predominates slightly. This appears to be due to the onset of the accommodative type of squint at this period. The age of incidence itself does not seem to be in any way a determining factor of the type of correspondence. Analysis of one group of cases, i. e., those of squint of undetermined cause, shows no conspicuous difference in the type of correspondence found throughout the range of incidence from birth to 5 years of age (after which no cases occurred) (chart 2).

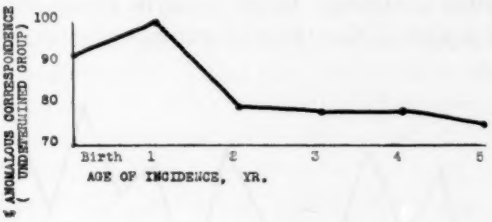

Chart 2.—Relation of age of incidence to anomalous correspondence of squint of undetermined cause.

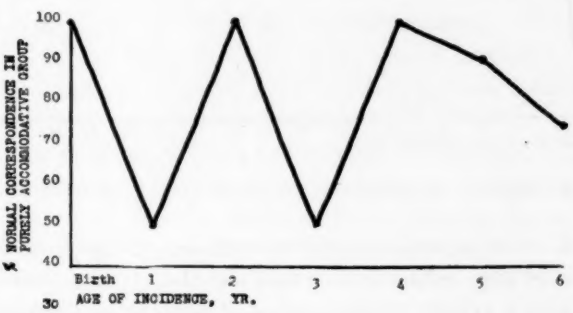

Chart 3.—Relation of age of incidence to normal correspondence in cases of purely accommodative squint.

This is also true of normal correspondence in the cases of purely accommodative squint (chart 3).

Relation of Correspondence to Duration of Squint.—It is generally held that the longer a squint has lasted the more certain it is to be associated with anomalous correspondence. This conclusion apparently is not justified. At first glance, a graph showing the duration of squint which represents all types of cases suggests a sharp increase in anomalous correspondence if the squint has lasted from six months to a year (chart 4).

However, it must not be forgotten that one cannot tell the type of correspondence in a child under 3 years of age. The subjects who can be examined within six months of onset will therefore have only that type of squint which begins at about this age (i. e., 3 years), and it has already been seen that this is the accommodative type. On analysis of cases of this one type, it will be seen that there are as many cases with normal correspondence after five years' duration as after six months' duration. Further, analysis of cases of the paralytic type, which serve as an even better control group, shows that there are an equal number of cases of normal and of anomalous correspondence for any given duration of squint. In the paralytic group, for example, even in the cases of squint of five years' duration and over, there were 8 of

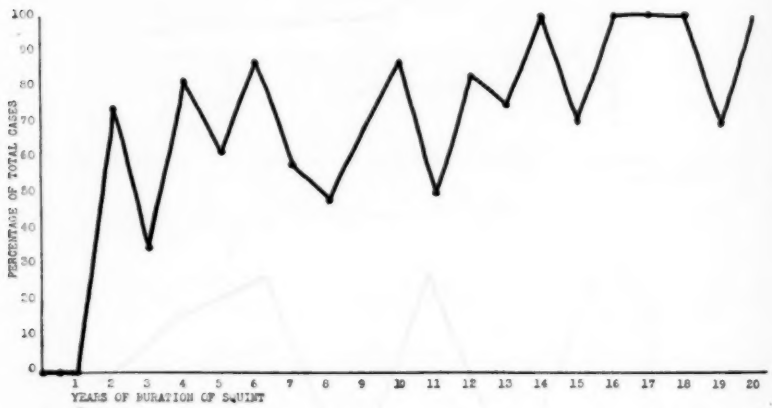

Chart 4.—Relation of anomalous correspondence to duration of squint.

normal and 9 of anomalous correspondence. Surely, if duration of squint were of any influence in changing the type of correspondence, one would find a greater predominance of anomalous correspondence in these cases.

Relation of Correspondence to Amblyopia.—Of the cases in which there was no amblyopia (half the total number of all types) anomalous correspondence was found in 69 per cent. This has been taken by some investigators, notably Travers,[2] to indicate that anomalous correspondence and amblyopia are mutually exclusive. It has been inferred that every squinter has a choice of anomalous correspondence or amblyopia as a means of getting out of his dilemma. If this were so, one would expect to find that persons with amblyopia have predominantly normal correspondence. This is not so, however, as only 43 per cent of the subjects with amblyopia (with a difference in acuity of the two

eyes of at least four lines on the standard Snellen charts) had normal correspondence.

Amblyopia seems to depend on factors other than correspondence, chiefly on whether the squint is monocular or alternating.

COMMENT

A statistical analysis of a series of cases of convergent squint shows certain correlations between the type of retinal correspondence and the motor disturbances. The most striking feature is the relationship between the type of correspondence and the angle of squint. Persons with squints of low angle have predominantly normal correspondence, whereas persons with squints of 15 to 20 degrees and over usually have anomalous correspondence. There is a sharp rise in the percentage of anomalous correspondence at approximately 15 degrees of convergence. The significance of this remains to be determined.

The angle of squint may be regarded as an index of the degree of excessive convergence innervation causing the squint. The squints of low angle fall largely into the accommodative group, and the excessive convergence innervation is caused by an abnormal amount of hyperopia, as first elucidated by Donders. The squints of large angle belong predominantly in the class for which no causal factor is known and are therefore said to be of undetermined cause.

Analysis of our cases indicates that age of incidence, duration of squint and presence or absence of amblyopia have little to do with determining the type of correspondence. All these factors have been considered by previous authors to be determining factors in the type of correspondence found in any case.

There is a third type of squint with an accommodative element, as well as an another, as yet undetermined, etiologic factor and this type falls halfway between the purely accommodative squint and the squint of undetermined cause in all aspects studied.

The close tie-up between squint of undetermined cause and the presence of anomalous correspondence raises the question as to which is the cause and which is the effect. It is customary to regard anomalous correspondence as an adaptation to the motor disturbance; if this is true, one can say that it seems to be conditioned by an angle of squint in excess of 15 degrees. (Many interesting speculations could be made regarding this but would not be profitable in the present state of knowledge.)

On the other hand, it is possible that the cause of the squint of undetermined origin is anomalous correspondence itself, that the latter is the cause of the excessive convergence innervation and that it is present at birth as an anomaly, instead of normal correspondence. It

must be admitted that this is an unorthodox theory, but it has been suggested previously. Verhoeff [4] concluded:

> . . . retinal correspondence, including its precision, is primarily dependent on hereditary sensory factors alone. Whether anomalous projection represents an hereditary reversion to a more primitive type of sensory relation or is acquired entirely by experience remains to be determined.

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4. Verhoeff, F. H.: Anomalous Projection and Other Visual Phenomena Associated with Strabismus, Arch. Ophth. **19**:663 (May) 1938.

PENICILLIN THERAPY OF EXPERIMENTAL INFECTIONS OF THE LENS AND VITREOUS WITH CLOSTRIDIUM WELCHII

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THE recent war has again shown that infections with Clostridium welchii are relatively common among battle casualties. According to Fisher and associates [1] prophylactic administration of penicillin locally and intramuscularly gave satisfactory results in preventing gas bacillus infection (gas gangrene) in wounds in which it was considered most likely to develop, i. e., in dirty, lacerated wounds. In none of 4,000 consecutive battle casualties thus treated did gas bacillus infection develop. Langley and Winkelstein,[2] in a study of 96 cases of gas bacillus infection of wounds at an evacuation hospital, concluded that penicillin in large doses was valuable when used in conjunction with surgical measures and antitoxin. Another war series, comprised of 33 cases of gas bacillus infection treated by local and parenteral administration of penicillin, was listed by Gledhill.[3] The incidence of infection was reported to be 11 per thousand battle casualties. The use of penicillin prophylactically did not prevent the onset of gas bacillus infection of wounds, but it seemed to control all the infections.

Experimentally, it has been shown by McIntosh and Selbie [4] in their work on mice, which are relatively susceptible to anaerobic infections, that penicillin is the most effective of the chemotherapeutic agents tested in controlling such infections. Hac [5] substantiated these

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From the Department of Ophthalmology, Columbia University College of Physicians and Surgeons, and the Institute of Ophthalmology, Presbyterian Hospital.

1. Fisher, G. H.; Florey, M. E.; Grimson, T. A., and Williams, P. M. de C.: Penicillin in Clostridial Infections, Lancet **1**:395 (March 31) 1945.

2. Langley, F. H., and Winkelstein, L. B.: Gas Gangrene: A Study of Ninety-Six Cases Treated in an Evacuation Hospital, J. A. M. A. **128**:783 (July 14) 1945.

3. Gledhill, W. C.: Gas Gangrene: Thirty-Three Cases with One Death Treated at a Forward General Hospital in Italy, Lancet **2**:264 (Sept. 1) 1945.

4. McIntosh, J., and Selbie, F. R.: Zinc Peroxide, Proflavine and Penicillin in Experimental Clostridium Welchii Infections, Lancet **2**:750 (Dec. 26) 1942.

5. Hac, L. R.: Experimental Clostridium Infection: IV. Penicillin Therapy, J. Infect. Dis. **74**:164 (March-April) 1944.

results in work on mice and guinea pigs; and Chain, Florey and co-workers [6] in their experiments on mice, rats and cats found penicillin to be most effective in controlling subcutaneous infections with Cl. welchii.

The incidence of anaerobic infections of the eye is probably greater than is generally accepted, especially in perforating war injuries. To my knowledge, no report is available on the etiology of intraocular infections in the recent war. It is safe to say that if routine cultures on thioglycollate broth were made of the vitreous of eyes enucleated because of post-traumatic panophthalmitis more anaerobic infections would be detected. In the literature a moderate number of cases are recorded in which anaerobes were identified as the cause of post-traumatic endophthalmitis. The first case was reported by Chaillous [7] in 1904. He added a second case in 1905.[8] Since these observations, 25 cases have been described in the literature. Morax [9] reported a case following explosion of a grenade in World War I. Ridley [10] cited a case of endophthalmitis due to infection with Cl. welchii following injury by an intraocular foreign body. Recovery followed evisceration. Rieger [11] observed 5 cases of septic endophthalmitis following perforating injury and described as characteristic a fulminant course with general malaise and fever. In these cases no gas bubbles were seen in the anterior chamber.

By culture of material obtained by vitreous punctures, various anaerobes were demonstrated in these cases. The fulminant development of the inflammation often made evisceration necessary. These cases occurred before penicillin became available.

Chaillous [8] and Schumacher [12] produced infection in the eyes of rabbits by injecting Cl. welchii into the anterior chamber and vitreous. In extensive work on experimental infection with anaerobes, Morax and Chiazarro [13] were unable to produce progressive endophthalmitis

6. Chain, E., and others: Penicillin as a Chemotherapeutic Agent, Lancet **2**:226 (Aug. 24) 1940.

7. Chaillous, J.: Infection traumatique du globe oculaire par un microbe anaérobic, Rec. d'opht. **26**:678, 1904.

8. Chaillous, J.: Deux cas d'infection traumatique du globe oculaire par un microbe anaérobie (bacillus perfringens), Ann. d'ocul. **134**:115, 1905.

9. Morax, V.: Des infections du globe oculaire par microorganismes anaerobies, Bull. Acad. roy. de méd. de Belgique **7**:321, 1927.

10. Ridley, F.: Gas Gangrene Panophthalmitis, Tr. Ophth. Soc. U. Kingdom **49**:221, 1929.

11. Rieger, H.: Ueber Wundinfektion des Augapfels mit Erregern der Gasbrandgruppe, Arch. f. Ophth. **137**:71, 1937.

12. Schumacher, G.: Anaerobe Bazillen bei Augenverletzungen, Klin. Monatsbl. f. Augenh. **46**:34, 1908.

13. Morax, V., and Chiazzaro: Sur l'infection due cristallin: Recherches cliniques et experimentales, Ann. d'ocul. **164**:241, 1927.

by injection into the anterior chamber. They succeeded, however, when they inoculated the lens directly. These observations were confirmed by an investigation in the Knapp Memorial Laboratory[14a] in which the chemotherapeutic effect of penicillin iontophoresis on the test lesion was studied. This treatment failed to check the infection, and it was concluded that "it appeared unlikely that treatment of anaerobic infections of the human eye . . . can overcome the twin disadvantages of the low susceptibility of the organisms to penicillin and the poor permeability of the lens."

In view of the failure of penicillin iontophoresis to check infection of the lens with Cl. welchii, the present study was undertaken with direct injection of penicillin into the lens. The investigation was extended to a similar treatment of infection of the vitreous produced by inoculation of the vitreous with the same strain of Cl. welchii. This therapy had been effective in control of experimental staphylococcic infections of the lens and of infections of the vitreous with pathogenic staphylococci and with pneumococci type III.[15] In a preliminary experiment, the sensitivity to penicillin of the strain of Cl. welchii was tested and found to be average, since 0.1 Oxford unit per cubic centimeter inhibited growth of the culture.

EXPERIMENTAL INFECTIONS OF THE LENS

Preliminary Experiment.—The concentration of penicillin in the lens was determined after the direct injection of 0.05 cc. of a solution of penicillin sodium containing 5,000 units per cubic centimeter. Six eyes were thus treated. In 1 rabbit the lenses were removed after forty-eight hours; the concentrations were 0.14 and 0.12 Oxford unit per gram, respectively, in the lenses of the right and the left eye. In the lenses of the other 2 rabbits only traces of penicillin were found after intervals of twenty-four and ninety-six hours.

Technic of the Experiments.—The technic of inoculation was similar to that used by von Sallmann.[14] The pupil was dilated with 2 per cent homatropine hydrobromide; local anesthesia was obtained by installation of 0.1 per cent nupercaine hydrochloride. General anesthesia was induced with ether. A 27 gage needle was inserted obliquely through the limbus at 12 o'clock. Infection was produced by injecting 0.05 cc. of a 10^{-4} dilution of the culture of Cl. welchii, as this had been found to be an adequate test dose. Both eyes of 12 rabbits were

14. von Sallmann, L.: (*a*) Penicillin and Sulfadiazine in the Treatment of Experimental Intraocular Infections with Staphylococcus Aureus and Clostridium Welchii, Arch. Ophth. **31**:54 (Jan.) 1944; (*b*) Experimental Study of Penicillin Treatment of Ectogenous Infection of Vitreous, ibid. **32**:179 (Sept.) 1944; (*c*) Penicillin Therapy of Infections of the Vitreous, ibid. **33**:455 (June) 1945.

15. Leopold, I. H.: Intravitreal Penetration of Penicillin and Penicillin Therapy of Infection of the Vitreous, Arch. Ophth. **33**:211 (March) 1945. von Sallmann.[14]

thus inoculated. In the first series, 8 eyes were treated after a three hour interval with 0.1 cc. of a solution of sodium penicillin containing 5,000 Oxford units per cubic centimeter. The injection was made in the same manner as that of the culture of Cl. welchii. In the second series, 8 eyes were treated similarly after a six hour interval. The remaining 8 eyes were used as controls. Ten of the 12 rabbits were observed at frequent intervals over a period of six weeks. The eyes were then removed and fixed in Zenker's solution. Sections were stained with hematoxylin and erythrosin and with the Van Gieson solution. One rabbit sustained a broken back at the time of injection. The animal was observed for four days and then killed. Another rabbit was found dead after twenty-five days. The eyes of these 2 rabbits were removed, and the histologic descriptions are included in the report on results.

RESULTS

The clinical changes observed in the first few hours after inoculation were probably caused for the most part by the trauma of injection. These changes consisted of dense fibrinous exudate in front of the pupil, dilatation of the vessels of the iris and strong aqueous flare with cells in the anterior chamber. The activity of the infection became evident in the next twenty-four hours. There were intense ciliary injection and purulent exudate in the anterior chamber. The wound in the lens became covered with yellow exudate, which extended into the superficial and deep layers of the anterior cortex. The iris was extremely swollen, and the pupil became occluded by an inflammatory membrane. The corneas of 3 eyes showed a high degree of vascularization. The purulent endophthalmitis spread rapidly into the posterior chamber and the vitreous. The globes gradually became shrunken, and histologic examination showed the picture of purulent panophthalmitis with severe destruction of the retina and choroid.

Clinical observations on the first series of eyes, which were treated after three hours, showed that the inflammation in the anterior segment was striking for the first two weeks but was not as intense as that in the untreated eyes. Posterior synechias formed, but in only 2 of the eyes did the pupils become occluded by an inflammatory membrane, as it did in all the control eyes. At the end of two weeks the infection in the anterior chamber gradually subsided. The inflammatory process did not progress in the lenses of the treated eyes, and after six weeks only 2 showed more than circumscribed linear cortical cataracts. These opacities interfered more or less with the clinical observation of the vitreous and the fundus. Only 2 treated eyes showed histologically an active infection of the lens; 1 of these was the only treated eye to show an abscess of the vitreous, with leukocytic infiltration of the retina. Three eyes showed localized atrophy of the retina, and 1 of these presented also a detachment of the retina (tables 1 and 2).

In the second series, treated after a six hour interval, 3 of the 8 eyes showed the clinical signs of a severe infection in the anterior chamber, with iris bombé, cells in the anterior chamber and seclusion

of the pupil. All the lenses which could be seen had linear cortical cataracts. Histologically, only 2 of the 8 treated eyes showed an uncontrolled infection in the lens and vitreous. One of these 2 eyes presented also a leukocytic infiltration of the cornea with exudate in the anterior chamber and necrosis of the iris. An accumulation of

TABLE 1.—*Effect of One Intravitreal Injection of Commercial Sodium Penicillin (5,000 Units per Cubic Centimeter) on Infections of Lens and Vitreous with Clostridium Welchii*

	Site of Inoculation			
	Lens		Vitreous	
Hours between inoculation and treatment	3	6	3	6
Number of eyes treated	8	8	8	8
Infection definitely checked	6	5	7	6*
Infection not checked	2	3	1	2
Number of control (untreated) eyes	4	4	8	8
Number of control eyes with panophthalmitis	4	4	6	7

* Infection checked but with extensive damage to the retina.

TABLE 2.—*Damage to Treated Eyes*

	Site of Inoculation			
	Lens		Vitreous	
Hours between inoculation and treatment	3	6	3	6
Number of eyes treated	8	8	8	8
Lens				
Clear	0	0	6	4
Traumatic cataract	6	8	1	2
Cataract complicated to infection	2	0	1	2
Vitreous				
Normal	7	6	6	1
Moderate number of inflammatory cells	0	0	1	1
Organized strands	0	1	1	6
Abscess	1	1	0	0
Retina				
Normal	5	5	3	0
Local atrophy	3	3	4	2
Detachment	1	2	1	6

leukocytes was evident in the posterior pole of the lens, while the vitreous was filled with exudate and the nerve was drawn forward by the organizing exudate. The other eye revealed an extensive abscess involving the lens, vitreous and retina. Three eyes showed localized atrophy of the retina.

EXPERIMENTAL INFECTIONS OF THE VITREOUS

Preliminary Experiments.—Ten eyes of mature chinchilla rabbits were used to determine whether it was possible to obtain a standard

test lesion with the intravitreal injection of the same strain of Cl. welchii as that used in the lens experiment. The bacilli were cultured eighteen hours in thioglycollate broth, centrifuged three times, washed in 0.9 per cent solution of sodium chloride and suspended in the following concentrations of the original culture: undiluted, 10^{-1}, 10^{-2}, 10^{-3} and 10^{-4}. It was determined that 0.05 cc. of a 10^{-1} dilution of the culture gave an adequately reproducible lesion which, in general, led to progressive and destructive endophthalmitis.

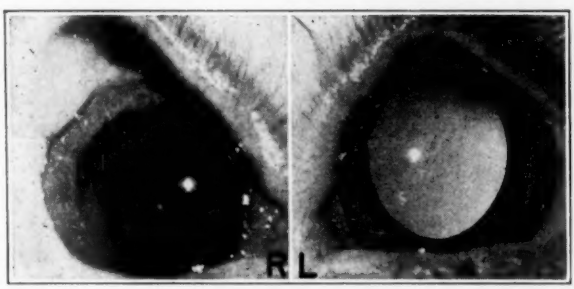
Technic of Experiments.—Local anesthesia was obtained with instillation and subconjunctival injection of a 0.1 per cent solution of nupercaine hydrochloride. An injection of 0.05 cc. of a 10^{-1} dilution of the culture of Cl. welchii was made into the vitreous while the eye was rotated downward with fixation forceps. The injection was made with the needle directed backward at an angle of 45 degrees to the axis of the globe, at a point 6 to 8 mm. behind the limbus. A tuberculin syringe and a short, sharp, 27 gage needle were used.

Two groups of experiments were conducted to ascertain the effectiveness of penicillin in controlling the course of the subsequent endophthalmitis. Into both eyes of 16 rabbits was injected, with the use of local anesthesia, the test dose of 0.05 cc. of a 10^{-1} dilution of the culture of Cl. welchii. In the first series of 8 rabbits, 0.1 cc. of a solution of sodium penicillin containing 5,000 Oxford units per cubic centimeter was injected into the vitreous of the right eye three hours after the inoculation, and 0.1 cc. of 0.9 per cent solution of sodium chloride was injected into the vitreous of the left eye. In the second series of 8 rabbits, the same dose was injected into the right eye six hours after inoculation, and the control eyes were given an injection of 0.9 per cent solution of sodium chloride. Examination with the slit lamp and ophthalmoscopic studies were made daily during the subsequent week and at frequent intervals thereafter. At the end of six weeks all the eyes were enucleated and fixed in Zenker's solution. Sections were stained with hematoxylin and erythrosin and the Van Gieson solution and studied histologically.

Results.—In the 16 control eyes the various stages of the infection were observed. The inflammatory signs attributable to the infection developed usually within forty-eight hours. At that time a moderate amount of purulent and fibrinous exudate was seen in the anterior chamber. Opacities in the vitreous developed rapidly, and details of the fundus could no longer be seen. By the third or fourth day a definite abscess was present in the vitreous in 10 of the 16 control eyes. The signs of inflammation in the anterior chamber often regressed after the third or fourth week, and the injection of the eye subsided. The anterior chamber cleared; the iris became atrophic, and the contracted pupil closed by organization of exudate. The infection remained localized in the eye, and no signs of a systemic infection were noted during the period of observation. Thirteen of the 16 control eyes were considered lost as a result of the infection. One eye exhibited an early inflammatory reaction in the vitreous, which cleared gradually, leaving little histologic evidence of its presence. In the other 2 eyes the inflammation did not lead to complete destruction of the retina

but resulted only in strands of vitreous and retinal detachment. Seven of the control eyes showed changes in the posterior cortex of the lens. In 2 of these eyes the changes became evident within the first few days and were considered to be of traumatic origin. In the other 5 eyes the cortical opacities became evident late in the period of observation and were considered to have been caused by infection.

Of the 8 eyes in the first series, treated three hours after inoculation, 4 showed localized atrophy of the retina at the site of injection, and another eye presented a flat detachment of the retina. Two eyes had cortical changes in the lens, appearing early in 1 eye and late in the period of observation in the other. Of the 8 eyes in the second series, treated six hours after inoculation, none demonstrated serious inflammatory changes in the anterior chamber; 4 revealed changes in the cortex of the lens, and 6 showed extensive changes in the vitreous, consisting of strands, with partial or total detachment of the retina.



Appearance of eyes showing effect of treatment with sodium penicillin on experimental infection of the vitreous with Clostridium welchii six weeks after injection of the drug. The right eye was treated with injection of the penicillin six hours after inoculation with the culture; the left eye served as control.

These changes were observed both clinically and histologically. Practically no inflammatory cells were observed histologically; so the active infection in all these eyes was considered to have been controlled, although extensive damage had probably destroyed the function of the eye.

COMMENT

The attempt to control anaerobic infections of the lens by the intralenticular injection of penicillin was decided on because this form of therapy had proved effective in staphylococcic infections of the lens [14] and because of the impossibility of introducing the drug into the lens by any other means. Certain weaknesses, however, were inherent in this type of therapy: Only minimal amounts of the solution could be injected into the lens, and the degree of leakage of the introduced substance from the wounds could not be controlled, nor could the distribution be judged. These disadvantages did not prevent the favorable results obtained with

the infection of the lens with Cl. welchii, which is one of the most reliable test lesions of the eye. To my knowledge, this is the first report of a beneficial effect of chemotherapy on an intralenticular infection with an anaerobe.

In the first series of eyes, treated three hours after inoculation, the infection was controlled in 6 or 8 eyes, and the damage to the globes was negligible except for the traumatic cataracts. In 1 eye the infection was probably checked, but the lens had still a clump of leukocytes and the retina exhibited partial atrophy. In the remaining eye, recorded as a therapeutic failure, an abscess formed in the vitreous. When the interval before treatment was prolonged to six hours, the infection was checked in 5 of 8 eyes, but the damage to the eyes by the formation of strands of vitreous with retinal detachment made it obvious that a longer interval could not be considered.

The results obtained with topical treatment with penicillin of infections of the lens may well be compared with those reported in the systemic treatment of infection with Cl. welchii in mice by McIntosh and Selbie[4] and Hac.[5] When the treatment was delayed longer than three hours after the inoculation, the percentage rate of survival decreased steeply. It has repeatedly been emphasized that satisfactory results with penicillin therapy in intraocular infections were dependent on the early initiation of the treatment. The observations in the present series not only confirm this experimental evidence with other types of infections but indicate that under the conditions of these experiments the interval between inoculation and treatment must be reduced to three hours.

In several of the beneficially treated eyes localized areas of retinal degeneration were observed which were similar to those produced by the injection of penicillin alone without the presence of an infection.[14e] Although the possibility cannot be excluded that the toxin of the bacilli produced some of the lesions in the retina, it is not improbable that the close topical relationship between a depot of the concentrated penicillin solution and the retina caused these changes. No attempt was made to use lower concentrations of penicillin to eliminate this danger, as it was essential to inhibit the growth of the organisms as early as possible. This purpose was thought to be achieved better with higher concentrations, since diffusion would be more rapid from a more concentrated solution.

In the vitreous experiments a reliable standard lesion had first to be determined. The one finally used, obtained by the injection of 0.1 cc. of a 10^{-1} dilution of a culture of Cl. welchii, was not entirely satisfactory, since in only 13 of the 16 control eyes did panophthalmitis develop. In 2 of the 3 remaining control eyes, the endophthalmitis was self limited but led to the formation of strands in the vitreous with retinal detachment. In the last control eye the inflammation subsided without causing great

damage. Nevertheless, the number and the condition of the beneficially treated eyes could be considered significant. The less favorable results in the series with the six hour interval could be interpreted similarly to the results in the respective series in the lens experiments.

CONCLUSIONS

1. Direct injection of penicillin into the lens and vitreous gave satisfactory results in controlling infections with Cl. welchii when the therapy was instituted within three hours after the inoculation.

2. Less favorable results were obtained when the interval between the infection and the treatment was increased to six hours.

3. The beneficial effect in the three hour series was obtained with moderate damage to the structures of the eye.

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LIPEMIA RETINALIS

Report of a Case

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AND
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LIPEMIA retinalis, although undoubtedly observed more frequently than published reports might indicate, only infrequently has been the subject of formal dissertations; and, because the intraocular picture is vividly striking, interest in this subject has been stimulated largely by the contributions of ophthalmologists. The antecedent and accompanying acidosis, whether sufficient to cause only drowsiness or so progressively severe as to cause the afflicted person to become comatose, is of course dramatic to the point of demanding remedial attention, to the exclusion, at least for the time being, of attention being directed to organs or systems that might be of interest to the examiner but do not involve the immediate question of life or death. It is not unusual, therefore, as occurred in this case—the sixty-sixth instance to be reported—that the eyegrounds are not immediately examined on admission. It is of interest, however, to mention that the patient under discussion already had undergone a previous, known episode of lipemia retinalis of diabetic origin. Wagener,[1] Lepard[2] and Kauffman[3] each have reported an instance of lipemia retinalis not attributable to diabetes mellitus, and it is possible that in the case recently reported by Igersheimer[4] the disease may not be essentially diabetic in origin.

REPORT OF CASE

D. C., a poorly developed, fairly well nourished white girl of 2⅓ years, was admitted in diabetic coma to the Babies Hospital in May 1931, her first admission.

Presented before the New York Academy of Medicine, Section of Ophthalmology, April 15, 1946. A discussion of this paper was published in the October 1946 issue of the ARCHIVES, page 521.

1. Wagener, H. P.: Lipemia Retinalis: Reports of Three Cases, Am. J. Ophth. **5:** 521-525 (July) 1922.

2. Lepard, C. W.: Lipemia Retinalis in Nondiabetic Patient, Arch. Ophth. **32:** 37-38 (July) 1944.

3. Kauffman, M. L.: Lipemia Retinalis, Am. J. Ophth. **26:** 1205-1208 (Nov.) 1943.

4. Igersheimer, J.: Ocular Disturbance in Case of Acromegaly Complicated by Diabetes, Arch. Ophth. **27:** 330-341 (Feb.) 1942.

She had been a normal full term baby, but delivery was difficult and forceps had been employed. Her parents stated that she had been healthy and active until twelve weeks prior to her admission to the hospital. The family history was essentially without significance, but one paternal grand-aunt had had diabetes mellitus in her middle years.

A neighborhood physician examined the child when she manifested listlessness and sleepiness, accompanied with anorexia, several weeks prior to her admission. Her appetite improved, without obvious reason, but the increased water intake, acetone breath and urinary frequency were attributed to the appearance of her first teeth. Consultation was requested on the day prior to her admission, when breathing became labored and the previously instituted diet failed to keep the urine free from sugar.

She was comatose on admission, and there were impairment of resonance and suppressed breathing over the lower left side of the chest. The systolic and diastolic blood pressures were 85 and 45 mm. of mercury, respectively. Urinalysis revealed a 4 plus reaction for sugar and acetone and diacetic acid. Determination of the blood sugar revealed a level of 500 mg. per hundred cubic centimeters. The carbon dioxide–combining power and the fat content of the blood were not determined. The eyegrounds revealed a classic picture of moderately severe lipemia retinalis. Response to indicated therapy was excellent, and the patient was discharged from the hospital one month after admission.

She was regularly observed in the Vanderbilt clinic during the next four years; admission again was advised in October 1935 because of an indolent septic infection of the left hand sequential to a moderate bruise sustained a few days before. She was discharged in less than two weeks, after intensive treatment directed toward the regulation of the diabetes mellitus. There was no suggestion of lipemia retinalis on this, her second, admission to the hospital. She returned at intervals for observation and examination in the Vanderbilt clinic until November 1940, when admission to the hospital again was advised to determine the cause of recurrent epistaxis and questionable enlargement of the liver. She was 11¾ years of age at this time.

Examination on this admission revealed a poorly developed but fairly well nourished girl, with a temperature of 101 F., a radial pulse of 130 beats per minute, essentially normal respiration and systolic and diastolic blood pressures of 130 and 100 mm. of mercury, respectively. The liver was moderately enlarged and the abdomen moderately distended, but the spleen was not palpable. There were some lesions of xanthoma diabeticorum over the elbows and knees. Urinalysis revealed a strongly positive reaction for sugar, acetone bodies and diacetic acid with a faint trace of albumin. Examination of the formed elements of the blood revealed moderate decrease in the red cells, leukocytosis and relative lymphocytosis. The sedimentation rate was 113 mm. in the first hour. The sugar content of the blood was determined as 612 mg. per hundred cubic centimeters, and the blood cholesterol was increased to 1,417.6 mg. per hundred cubic centimeters. Sulfobromophthalein sodium and bilirubin excretion tests gave normal results. The carbon dioxide-combining power was not determined.

The eyes were essentially normal externally, but their ophthalmoscopic appearance was unmistakably that of lipemia retinalis, which was in accord with the decidedly creamy color of the blood plasma obtained on the day after the patient's admission. The margins of the disks were visualized with difficulty, but the papillary and peripapillary vasculature was a pink-yellowish white and presented no manifest structural contrast to the background of the underlying choroidal

vasculature. The latter uniformly exhibited the same coloration except at the extreme periphery, where the whitish appearance gave way gradually to a yellow-pinkish tinge.

On the day after admission the onset of symptoms characteristic of impending diabetic coma necessitated the administration of appropriate treatment, consisting in this instance in furnishing constantly available insulin in Ringer's solution intravenously. The mild anemia was treated by transfusions of citrated blood,

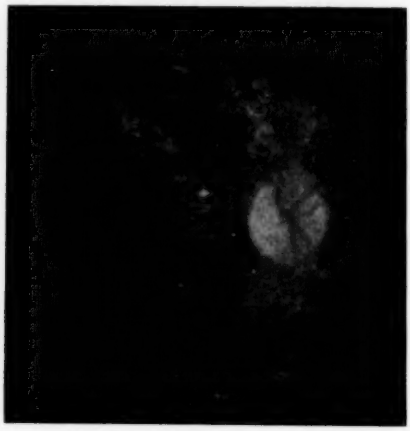

Fig. 1.—Right eye in a case of lipemia retinalis (third day in hospital).

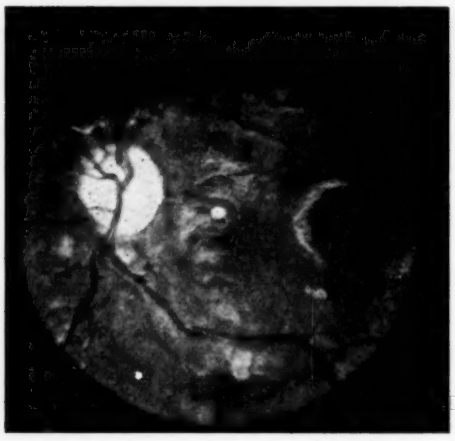

Fig. 2.—Left eye in a case of lipemia retinalis (twenty-first day in hospital).

with some improvement in the values obtained for all the formed elements except the red cells. The latter did not increase in number, but studies of blood smears revealed no evidence of any blood dyscrasia. Ophthalmologic examination on the third day in the hospital revealed relatively marked improvement in the intraocular coloration. The usually easily discernible structures no longer were observed with difficulty, although the general appearance still was strongly sug-

gestive of lipemia retinalis. Retinal photographs were taken on this day because of the generally improved condition of the patient. Subsequent pictures taken three weeks after admission revealed essentially normal eyegrounds, which, however, had been evident on the ninth day after her admission.

The patient was discharged three and one-half weeks after admission, with only minimal enlargement of the liver still determinable; the hemoglobin was evaluated

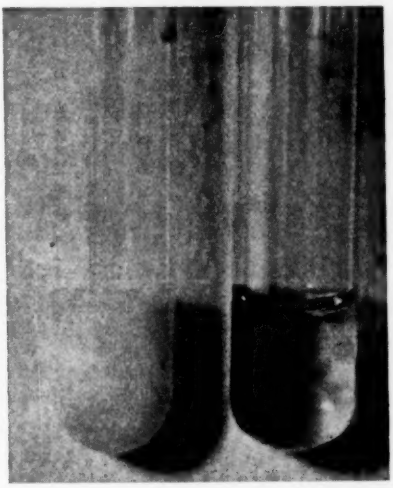

Fig. 3.—Blood serum, showing color contrast of samples obtained on the second and the twentieth day in the hospital.

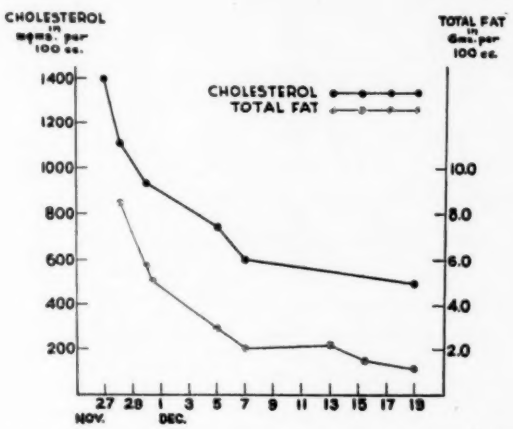

Fig. 4.—Graph of values for blood fat during hospitalization.

at 100 per cent and the red blood cells at 3,850,000 per cubic millimeter, and the diabetes was under excellent control. The cholesterol content, as well as the total fat content, of the blood just prior to discharge returned to near-normal levels of 4.5 and 1.0 Gm. per hundred cubic centimeters, respectively.

COMMENT

Lipemia retinalis, the literature of which has recently been adequately reviewed elsewhere, is an uncommonly observed phenomenon seen in the course of an acidotic episode of some severity, occurring chiefly in younger diabetic persons. In this condition abnormal increases of emulsified neutral fats in the blood stream are manifested ophthalmoscopically by characteristic deviations from the normal in the paler color of the eyeground and its contrasting structures. More than 60 cases have been reported to date; however, in at least 3 of these the condition has unquestionably occurred in patients without diabetes. Prior to the use of insulin, in 1922, 24 cases were reported, in 17 of which the patient died in diabetic coma.

In the case herewith reported (which appears to be the sixty-sixth on record) the patient experienced two known episodes of lipemia retinalis. The first occurred when she was 2 years of age, on her first admission to the Babies Hospital, in May 1931, while in diabetic coma; the next admission, during which she approached but did not go into coma, was in November 1940, when she was nearly 12 years of age. Values for cholesterol and total fat concentrations determined during the second admission are charted. Photographs of the eyegrounds and of specimens of the blood serum illustrate the color contrasts at the peak of the episode and prior to the patient's discharge from the hospital.

60 East Seventy-Fifth Street.

INFLUENCE OF THE SUTURE ON COMPLICATIONS FOLLOWING CATARACT OPERATION

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THE first extraction of cataract by Daviel—its two-hundredth anniversary was last year—was followed by several important improvements in surgical technic: von Graefe's combined extraction, the intracapsular method, akinesia, fixation of the superior rectus muscle and suturing of the wound. All these procedures originated several decades ago. By their gradual perfection, the incidence of complete failures has been reduced to less than 1 per cent, as compared with 25 per cent two hundred years ago, 6 to 34 per cent in the statistics of eighty to one hundred and twenty years ago and 3 to 4 per cent in the last year of von Graefe's life. The latest measure, although not a technical one, in the direction of eliminating postoperative infection is the prophylactic use of sulfonamide drugs (Guyton and Woods [1]) and of penicillin (Dunnington and Locatcher-Khorazo [2]). As things now stand, all these improvements together relegated the dreaded postoperative inflammation to a place second in importance to the other types of postoperative complications, such as retinal detachment, glaucoma, corneal degeneration and expulsive hemorrhage.

Today, a modification of the cataract operation can hardly improve the results impressively, because there are so few failures. It is like cutting off one fifth of a second from the record of the 1 mile run. This is harder now than was an improvement of one second thirty years ago. Only comparison on the basis of a really large material would show the advantages or disadvantages of a modification of the operation for cataract.

The use of the suture in the operation for cataract is steadily gaining followers. A decade ago it was used in but few hospitals. In 1944 an article in the *Bulletin of Practical Ophthalmology* [3] of Green's Eye

1. Guyton, J. S., and Woods, A. C.: Oral Use of Prophylactic Sulfadiazine for Cataract Extraction, Am. J. Ophth. **26**:1278, 1943.

2. Dunnington, J. H., and Locatcher-Khorazo, D.: Value of Cultures Before Operation for Cataract, Arch. Ophth. **34**:215 (Sept.) 1945.

3. Use of Sutures in Cataract Extraction: Report of Survey, Bull. of Pract. Ophth., May 1944, vol. 14, no. 1.

Hospital, based on a questionnaire answered by 398 ophthalmic surgeons (not answered by 303) disclosed that 79.65 per cent used sutures in the cataract operation. There can be little doubt that this figure is steadily growing. However, 13.57 per cent used conjunctival sutures only; so this number can be deducted from the first from the point of effective protection to the wound. The main reason for the acceptance of the suture by the majority of ophthalmic surgeons in a few short years is the perfection of the needle and thread, which makes introduction of the stitch easy, avoiding damage to the tissue; thus, no infection occurs along the thread. Several excellent papers have dealt with the many advantages gained by the suture. It is not the purpose of this paper to elaborate on this subject. If only the great decrease in the number of wound ruptures and the greater postoperative freedom of movement granted the patient are considered, it is more than worth while to prolong the operation by inserting sutures. Any one who has done a large series of extractions without sutures and remembers the wound ruptures—which amounted to 6 to 20 per cent in various statistical reports—awakening the patient with pain, usually in the early morning hours, as well as the psychologic effect on the patient, will make use of the suture.

However, in the selection of the suture, there is a choice of several types. It would be a simple matter to pick the best suture by a comparison of the results if the same surgeon used the various kinds on about an equally large number of patients. The next best method is to compare the results of the various surgeons with one method, in which case the personal factor, the difference in technic and the making up of statistics will somewhat blur the picture. This method will be followed later in this paper, consideration being given to the series in which one or more deep corneoscleral sutures were used, the technic was not changed during the series and the complications and results were fully or partly published (table 1). These limitations explain the omission of large series from this paper, e. g., those of Knapp,[4] Greenwood and Grossman,[5] Berens and Bogart,[6] Klein[7] and F. A. Davis.[8]

4. Knapp, A.: Complications of the Forceps Intracapsular Operation for Cataract, Arch. Ophth. **16**:770 (Nov.) 1936.

5. Greenwood, A., and Grossman, H. P.: An Analysis of 1,343 Intracapsular Cataract Extractions by Forty-Eight Operators Following the Verhoeff Method, Tr. Am. Ophth. Soc. **33**:353, 1935.

6 Berens, C., and Bogart, D.: Certain Postoperative Complications of Cataract Operations, Tr. Sect. Ophth., A. M. A., 1938, p. 238.

7. Klein, M.: Operation for Cataract, Brit. J. Ophth. **26**:93, 1942.

8. Davis, F. A.: Intracapsular Cataract Extraction, Arch. Ophth. **31**:367 (May) 1944.

The papers of Leech and Sugar [9] and of McLean [10] present the results for their series with the conjunctival suture as well as for the series with the deep suture. It is instructive to compare the results of the two series obtained by the same surgeons.

The suture used to close the cataract wound may be superficial, i. e., conjunctival, or deep, i. e., corneoscleral. Between these two types is the episcleral suture. Several series have proved that conjunctival sutures do not reduce, or only insignificantly reduce, the incidence of wound rupture.

THE DEEP SUTURE

The deep suture is basically of two types:

1. The Kalt [11] suture. A vertical bite is taken in the cornea, and a vertical or, as later advised, a horizontal bite, in the sclera. Between the two bites the thread runs on the surface. Modifications of this type are Verhoeff's suture,[12] method A, and Burch's suture,[13] both of which include the conjunctiva as well, and the sutures of Liégard,[14] Stevenson,[15] Higgins,[16] Stallard [17] and Mullen,[18] with both bites horizontal.

2. The Mendoza [19] suture. A shallow incision is made in the cornea or limbus, and a suture is placed in the lips of the incision at exactly appositional points. This method has several modifications. The differences are in the site of the preliminary incision, whether in the cornea

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9. Leech, V. M., and Sugar, H. S.: Reduction in Postoperative Complications of Cataract Operations, Arch. Ophth. **21**:966 (June) 1939.

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11. Kalt, E.: On the Corneal Suture in Cataract Extraction, Arch. Ophth. **23**:421, 1894.

12. Verhoeff, F. H.: A Corneo-Sclero-Conjunctival Suture in Operation for Cataract, Tr. Am. Ophth. Soc. **25**:48, 1927.

13. Burch, E. P.: The Corneo-Scleral Suture in Military Ophthalmology, Mil. Surgeon **93**:286, 1943.

14. Liégard, H.: Une modification au procédé de suture de la cornée dans l'operation de la cataract, Ann. d'ocul. **149**:119, 1913.

15. Stevenson, cited by Beard, C. H.: Ophthalmic Surgery, ed. 2, Philadelphia, P. Blakiston's Son & Co., 1914.

16. Higgins, S. G.: The Closure of the Cataract Incision, Am. J. Ophth. **13**:1099, 1930.

17. Stallard, H. B.: A Corneo-Scleral Suture in Cataract Extraction, Brit. J. Ophth. **22**:269, 1938.

18. Mullen, C.: A Corneo-Scleral Suture for Intraocular Surgery, Arch. Ophth. **32**:522 (June) 1944.

19. Mendoza, S. F.: Nouveaux faits de suture de la cornée dans l'extraction de la cataracte, Bull. et mém. Soc. franç. d'opht. **10**:63, 1892.

TABLE 1.—*Data on Several Series of Cases of Cata*[illegible]*extracti*

Author and Series	No. of Cases	Type of Suture	Type of Operation	Delayed and/or Incomplete Closure of Wound	Hemorrhage in Anterior Chamber
Hilding					
Series 1.....	105	Verhoeff, two sutures	Three peripheral iridectomies	.....	.....
Series 2.....	82	Four sutures similar to McLean's	No iridectomy; knife and scissors; intracapsular extraction 70 + 5%†	.....	.....
Hughes and Owens					
Series 1.....	425 (no complicated cataract)	McLean's, one or two	Combined intracapsular extraction	1.9%	10.8 %
Series 2.....	380 (no complicated cataract)	McLean's, one or two	Round pupil, intracapsular extraction	0.3%	4.5%
Kirby.....	100 (consecutive cases in which the intracapsular method was used)	Appositional, three following incision	90 + 1% † intracapsular; 52% round pupil	.....	8%
Leech and Sugar					
Series 1.....	150 (selected)	Conjunctival	Intracapsular extraction, 34%	6% No chamber at first dressing	11.2%
Series 2.....	150	Stallard's	Intracapsular, 51%	2.6%	4.6%
McLean					
Series 1.....	64 (unselected)	Conjunctival	Intracapsular extraction, 88%	14.1% delayed reformation of chamber or closure of the wound	15.7%
Series 2.....	110 (unselected)	McLean's (two sutures in 11 cases)	Intracapsular extraction, 88%	3.6%	2.8%
O'Brien.....	220 (unselected)	Episcleral (six sutures)	Keratome + scissors, 110; Graefe knife, 110; intracapsular extraction, 76%	.....	.....
Roper.....	27 (unselected)	Lancaster's (two or three, appositional)	Intracapsular extraction, 85%	.....	3.7%
Stallard.....	107	Stallard's	Intracapsular extraction, 25%	.....	None
deRoetth					
Series 1.....	150 (unselected)	Verhoeff, method A	Intracapsular extraction, 63 + 14% †	No chamber at first dressing, 5%; chamber formed in one week, 2%	6.6%
Series 2.....	150 (unselected)	Author's modification of McLean's, one suture	Intracapsular extraction, 67 + 7% †	No chamber at first dressing, 5%; formed in one week, 0	4.7%
Series 3 *.....	35 (unselected)	Author's modification of McLean's, two sutures	Intracapsular extraction, 22 + 3 † cases	No chamber at first dressing, 2; chamber formed in one week, 1	2 cases

* Owing to the small number of cases, the incidence of complications is not given in percentages.

† Cases in which the capsule was removed in toto after expulsion of the lens.

Hemorrhage in Anterior Chamber	Prolapse of Iris and/or Vitreous	Amount of Astigmatism Average	Iritis	Retinal Detachment	Glaucoma	Corneal Dystrophy	Vision, Cases with Extraneous Causes of Poor Vision Excluded
.....	2% (incarceration or clay prolapse)	About 1.50 D.	.....	.....	.....	.....	20/30 or better, 88%
.....	for two series combined	For two series combined	.....	.....			(results for two series combined)
10.3 %	1.7%	With one suture, 1.7 D.	2.8%	1.3%	2.4%	.....	20/30 or better, 85.7%; less than 20/200, 3.3%
4.3%	1.2%	With two sutures, 1.4 D.	1.4%	0.5%	1.6%	.....	20/30 or better, 91.7%; less than 20/200, 1.9%
9%	1% (?)	About 1.5 D.	6% + 5% in eyes with previous uveitis	1%	3% + 3% transient		No selection of cases: 20/30 or better, 86% 20/200 or less, 4%
11.2%	4.6% (iris or vitreous)	1.94 D.	.....	.....	.. ..	.....	.....
4.6%	4%	1.82 D.	.....	.....	.....	.....	.....
18.7%	0.9%	2.56 D.	.....	.....	.....	.....	.....
3.6%	2.7%	1.32 D.	.....	.....	.....	....	.....
.....	.....	Graefe knife, 2.42 D.; keratome and scissors, 1.64 D.	.....	.....	.....	.....	20/30 or better, 91.8%
3.7%	7.6%	1.53 D.	.....	.....	.....	.....	....
None	.....	1.5 - 2.5 D.	.....	.....	. ..	.....	.....
6.6%	1.7%; vitreous incarcerated, 7.4%	2.13 D.	4.0%	1.3%	2.6%	2%	20/30 or better, 91.5%; less than 20/200, 3.8%
4.7%	Incarceration of iris, 3%; vitreous incarcerated, 1.3%	2.12 D.; uncomplicated cataract, 1.92 D.	4.6%	2%	2%	0	20/30 or better, 90.3%; less than 20/200, 3.8%
2 cases	Vitreous incarcerated, 1 case	1.66 D.	0	0	0	0	20/30 or better in 30 out of 31

or the limbus (Lancaster [20]), forming a corneal pocket (Müller,[21] Walker [22]) or a scleral flap (DeVaul,[23] Hymes [24]); in using the conjunctiva to cover the wound (McLean [10]), and in introducing the stitch after the section is completed (Kirby [25]) or rethreading it (Verhoeff) or in introducing it when the section is half completed (Weeks [26]).

It seems less of a risk to put in the suture before the section is made, in order to avoid manipulation with the suture on the opened eye. To place the suture after section, it takes such a highly skilled surgeon as Kirby, who states that he has never had occasion to regret appositional suturing after the section was made. Appositional sutures give a perfect adaptation of the edges of the wound. On the other hand, a suture running over the wound, on the surface of the cornea and sclera, may depress the wound. The wound is well covered, and the nutrition of the cornea is better if there is a conjunctival flap. All these conditions are fulfilled with McLean's suture, which, according to the compilation in the Green *Bulletin,* has the largest number of users. Spaeth [27] acknowledges it as the best one, and Kirby considers it the best preplaced suture.

In 10 consecutive cases in which I used this suture, I found that the reverted conjunctival flap, covering about the upper one fifth or one fourth of the limbus, prevented the surgeon from seeing that portion of the cataract knife which was in the anterior chamber (McLean's figure 1 *D* [10]). This made it difficult to move the knife in the plane of the limbus. The result was cutting the iris in 3 cases and severing the suture with the knife in 1 case. This difficulty can partially be eliminated by lifting and manipulating the conjunctival flap. This requires a skilful, trained assistant. The difficulty is increased when

20. Roper, K. L.: Lancaster's Technique of Cataract Extraction, Am. J. Ophth. **26**:540, 1943.

21. Müller, L.: Ein Operationsverfahren für komplizierte Stare und luxierte Linsen, Klin. Monatsbl. f. Augenh. **41**:11, 1903.

22. Walker, C. B.: Exactly Appositional Sutures in Cataract Operation, Tr. Am. Ophth. Soc. **27**:51, 1929.

23. DeVaul, C. H.: A New and Improved Method for the Closure of Cataract Incision, Am. J. Ophth. **25**:1078, 1942.

24. Hymes, C.: Scleral Flap Incision with Scleral Sutures for the Cataract Operation, Arch. Ophth. **34**:374 (Nov.-Dec.) 1945.

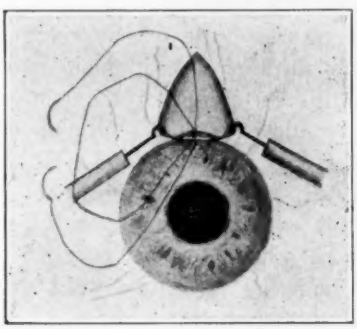
25. Kirby, D. B.: Further Experiences with a System of Intracapsular Extraction of Cataract, Arch. Ophth. **31**:302 (April) 1944.

26. Weeks, C. L.: New Corneoscleral Suture Technic, Arch. Ophth. **27**:1199 (June) 1942.

27. Spaeth, E. B.: Principles and Practice of Ophthalmic Surgery, Philadelphia, Lea & Febiger, 1944, p. 629.

two sutures are used. It was further observed that the suture caused moderate edema of the conjunctival flap; moreover, when the time came to remove it, the mattress suture cut into the conjunctiva which, with such a fine thread and soft tissue, was to be expected.

To avoid these difficulties, the operation was modified in the following way: A vertical incision 8 mm. in length is made in the bulbar conjunctiva from the 12 o'clock point on the limbus. The conjunctiva is undermined 3 to 4 mm. both nasally and temporally, especially close to the limbus. The preliminary groove is made at the base of the undermined conjunctiva. The Tooke knife proved to be the best instrument for this purpose. The groove is made in the middle of the gray corneoscleral transitional strip, which is about 1 mm. wide at the upper portion of the limbus. The incision should penetrate the overlapping scleral tissue and reach actually into the corneal tissue. The appositional suture is introduced at the 12 o'clock position, i. e., correspond-



Deep corneoscleral suture; vertical incision of the bulbar conjunctiva from the 12 o'clock point, with preliminary incision in the middle of the gray transition strip. This incision is made easier by pulling the conjunctiva to the side with hook or forceps. After insertion of the appositional suture, the bulbar conjunctiva is left in its original place. The next step is the Graefe knife incision.

ing to the vertical wound in the conjunctiva. The loop of the thread—only one loop—is pulled to the temporal side (figure). With the conjunctiva in the anatomic position, the incision is easy to perform, and if the preliminary groove is deep enough a good conjunctival flap is gained without severing the preplaced suture. There really will be a nasal and a temporal flap, instead of one flap. The knot will rest on the cornea and sclera and will not interfere with the circulation of the conjunctiva. The same procedure can be used with two sutures, in which case the incisions perpendicular to the limbus are placed at the 11 and the 1 o'clock points, and it is advisable to use a fine conjunctival suture after the corneoscleral sutures are tied to secure the middle flap to the bulbar conjunctiva, which has a tendency to revert over the cornea.

The value of the single suture was tested in a series of 150 consecutive extractions and the value of two sutures in 35 extractions, and the results were compared with those in a series of 150 consecutive extractions in which method A of Verhoeff was used. The two series followed each other chronologically, being interrupted only by the 10 cases in which the original McLean suture was used. All cataract extractions except the linear type were included as they came, both operations for complicated and operations for uncomplicated cataract. It is the complicated cataract which is apt to have more operative and postoperative complications; thus, a technical improvement should show its effectiveness in just such cases. This statistical report is not a large one, but it has the advantage of being based on operations performed by the same surgeon, in two hospitals, where the care of the patients was the same.

Although the value of a suture in the cataract operation shows only after the suture is tied, it is proper to give the operative steps in a few words: Van Lint akinesia of the orbicularis muscle; suture fixation of the superior rectus muscle; vertical incision of the conjunctiva at the 12 o'clock point; undermining of the conjunctiva; placement of a groove in the limbus; insertion of the suture; section with the Graefe knife and securing of fairly large nasal and temporal conjunctival flaps; complete or peripheral iridectomy; grasping of the capsule 2.5 mm. below the anterior pole with the Arruga or Imre capsule forceps, and exertion of 50 per cent pull and rotation and 50 per cent push from below with the Imre half-ring instrument (named the Budapest instrument by Guyton). In most cases the lens will tumble. In patients older than 75, the capsule is caught above the anterior pole, and the lens is not tumbled. If the capsule breaks, a new grasp is sought and an attempt made to complete the intracapsular extraction. In cases of extracapsular extraction, after the delivery, the cornea is slightly lifted with the help of the suture, and the edge of the capsule is caught as far down in the pupillary area as possible. This measure is omitted only if the vitreous is bulging menacingly. The suture is tied, but not so tightly as to cause a furrow in the cornea; the iris repositor is always used, followed by a careful inspection of the wound, to ascertain especially the position of the conjunctival flaps. Physostigmine ointment is given in cases of round pupil extractions and intracapsular extraction, and a binocular bandage is placed for twenty-four hours. On the next day the bandage of the fellow eye is removed, and the patient may sit up in a chair. The suture is removed on the eleventh day.

From this point, the type of suturing may determine how the wound heals, and the suture is in part responsible for the postoperative complications and for the amount of astigmatism. However, there are

several other factors at play, to mention only the most important ones: the site of the wound, round pupil extraction or complete iridectomy, intracapsular or extracapsular extraction, occurrence of infection during operation and after-care.

The number of intracapsular and of round pupil extractions is given in table 2.

TABLE 2.—*Distribution of Intracapsular Extractions and Peripheral Iridectomies in the Three Series*

	Number of Cases	Intracapsular Extraction	Capsule Torn; Removed in Toto	Peripheral Iridectomy
First series	150	89	23	0
		112 (74.6%)		
Second series	150	103	11	12
		114 (76%)		
Third series	35	22	3	1
		25 (71.4%)		

COMPLICATIONS OF WOUND HEALING

Delayed Refilling of the Anterior Chamber.—This complication indicates that the wound is not closed. The anterior chamber was flat twenty-four hours after the operation in 16 cases in the first series (Verhoeff's method A), but in only 3 of these was the chamber not refilled at the end of one week. In the second series (new suture) the corresponding figures were 8 and 0, respectively. When two sutures were used, there was only 1 case with no chamber for a few days. Equally revealing are the figures when the duration of the shallowness of the chamber is examined.

The period during which the anterior chamber remained shallow is tabulated.

	Series		
No. of Days	I	II	III
2	4	6	1
3	7	4	1
4	3	..	..
5	2	2	..
6	3	1	..
7	3	1	1
8	1	..	..
21	1	..	..
	24 (16%)	14 (9.3%)	3 (8.6%)

These figures show that all cases with the new suture had a chamber of normal depth in seven days.

It is difficult to compare these data with those of the other publications. For example, McLean gives figures for delayed formation of the anterior chamber; Leech and Sugar, for absence of the chamber at

the first dressing, and Hughes and Owens,[28] for incomplete closure of the wound. These conditions are evidently not exactly the same.

Hemorrhage in the Anterior Chamber.—Hemorrhage in the chamber is almost always due to reopening of the wound after new capillaries have formed. However, in diabetes there is a tendency to hemorrhage from the iris, according to Philps.[29] Collins [30] gave microscopic evidence that there are young blood vessels in the wound on the third day, and it is known that hyphema usually occurs on the fourth to the sixth day. Vail [31] emphasized the importance of trauma in the majority of cases of hyphema but stated that increased intraocular pressure from rapid filling of the anterior chamber is a predisposing factor. Neff [32] found that trauma, at a critical time, was instrumental in causing hyphema and that the constitutional background of the patient had a definite significance. Vail found from the statistics of 17 authors that the average incidence was 7.9 per cent. When these series were studied, deep sutures had not yet been used.

Even with conjunctival sutures the incidence of hemorrhage in the anterior chamber was 9.2, 11.3 and 18.7 per cent, respectively, in the series of Davis,[8] Leech and Sugar [9] and McLean.[10] The site of the wound is also a factor. The more the wound is limited to the cornea, the less is the incidence of hyphema. All in all, hyphema is a fairly good indicator of the effectiveness of the suture. But, as Hilding [33] put it, safe closure is a relative term; there is no suture which can resist any amount of force. The incidences in my three series were 6.6, 4.7 and 5.7 per cent, respectively. The lowest figures are those of Stallard, with no hyphema in 107 cases (but Leech and Sugar, using the same suture, had an incidence of 4.6 per cent; of McLean, with 3.6 per cent, using one suture; of Hughes and Owens, with 4.6 per cent, using one or two sutures, and of Roper,[20] with 3.7 per cent, using two or three sutures).

Prolapse of the Iris.—This complication, occurring in the first days after operation, reveals a violent, sudden opening of the wound. Prolapse of the vitreous belongs in the same category; it usually is associated with incarceration of the iris. Late subconjunctival prolapse of the iris develops gradually; and, as Klein pointed out, the prognosis is serious.

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28. Hughes, W. F., and Owens, W. C.: Extraction of Senile Cataract, Tr. Am. Ophth. **49**:251, 1945.

29. Philps, A. S.: Post-Cataract Hyphema, Brit. J. Ophth. **24**:122, 1940.

30. Collins, E. T., cited by Philps.[29]

31. Vail, D.: Hyphema After Cataract Operation, Am. J. Ophth. **24**:920, 1941.

32. Neff, E. E.: Factors Affecting Hemorrhage Following Extraction of Cataract, Arch. Ophth. **33**:192 (March) 1945.

33. Hilding, A. C.: Experimental and Clinical Studies in Certain Safety Factors in Closure of Cataract Incisions, Am. J. Ophth. **28**:871, 1945.

The incidence of prolapse of the iris in my first and second series was 3.3 and 1.3 per cent, respectively, but there was incarceration of the vitreous in 7.3 and 1.3 per cent, respectively. Hilding had prolapse of the iris in 5 per cent of his second series, with four sutures but without iridectomy. From the diagrammatic representation of the final shape of the pupil in his 184 cases, 6.8 per cent had a more or less drawn-up pupil, and 16.5 per cent had complete iridectomy, his paper proving that round pupil extraction cannot be used in an unbroken, unselected series. No doubt the round pupil extraction with peripheral iridectomy or iridotomy is the ideal method. The best visual results and the least complications were obtained in the cases of peripheral iridectomy and intracapsular extraction of Hughes and Owens, but this series is a selected material, after elimination of the cases of complicated cataract, the cases with broken capsule and the cases in which iridectomy had to be performed for some reason. Kirby saved the sphincter in 52 per cent. This, it seems, is close to the maximal percentage in which round pupil extraction with peripheral iridectomy can be performed without undue risk of prolapse of the iris or of drawing up of the pupil. Of his 100 cases, 62 were considered fit for round pupil extraction, but in 10 of these complete iridectomy had to be done.

It does not seem to make any difference which type of deep, appositional suture is used in the prevention of postoperative prolapse of the iris. But even several deep sutures do not prevent the drawing up of the pupil if no peripheral iridectomy is done.

Other Complications of Wound Healing.—Such complications as eversion of the cornea, gaping or unevenness of the wound or fistula in the wound should not occur with deep sutures, or should occur only when excessive force is applied to the eye.

Postoperative Astigmatism.—The amount of astigmatism indicates the deformity of the cornea due to the wound. Several factors determine its amount, among which are the length and the site of the wound. A scleral wound is followed by more astigmatism than a corneal one. The cornea is more apt to regain its normal curvature than is the sclera. On the other hand, when the cornea is stretched, as in loop extraction or eversion of the cornea, there will be more astigmatism. A tangenital wound through the cornea probably causes more astigmatism than a perpendicular one. O'Brien [34] made a valuable contribution to this point. In one half of an unselected series of 220 cataract extractions he used the Graefe knife; in the other half, the keratome and scissors. The average incidences of astigmatism were 2.42 and 1.64 D., respectively, with six episcleral sutures.

34. O'Brien, C. S.: Comparison of the Keratome-Scissors and the Graefe Knife Incisions for Cataract Extraction, Am. J. Ophth. **26**:504, 1943.

In my three series the average amounts of astigmatism were 2.3, 2.09 and 1.66 D., respectively. In each series about one-half the patients were examined only once, about seven weeks after operation, when the final refraction was done. The other half were examined again in four to twelve months. These values, 2.32 and 2.09 D., are higher than those of the other authors who used deep sutures (1.32 to 1.82 D.). The series of Hughes and Owens carries perhaps the most weight, because of the large number of cases. They had 1.7 D. when one suture, and 1.4 D when two sutures, were used. However, the cases of complicated cataract and extracapsular extraction were excluded. If this was done in my second series (in which one suture was used), the average amount of astigmatism would be 1.92 D. Eighteen of my patients had operation for cataract on both eyes; on one eye the single suture and on the other eye two sutures were used; the average amounts of astigmatism were 1.81 and 1.42 D., respectively, for the two eyes. Thus, when two deep sutures were used, the postoperative astigmatism was 0.3 to 0.4 D. less than that when one deep suture was used. Compilation of the data from the literature shows that with one deep suture the astigmatism was from 1.50 to 2.00 D. and with two deep sutures from 1.4 to 1.5 D. Only McLean's series is an exception; 99 cases with 1 suture and 11 cases with two sutures gave an average of 1.32 D.

OTHER POSTOPERATIVE COMPLICATIONS

Postoperative Iritis.—This complication is almost exclusively caused by primary infection; therefore it cannot be expected that the suture would decrease its incidence. The intracapsular extraction was an important step in this direction by not leaving behind any lens matter, which is a good medium for most of the bacteria of the conjunctival sac. Iritis occurred in 4 and 4.6 per cent, respectively, of two series and in none of the third series. In half these eyes there had been some previous intraocular disease.

In the series of the other authors the incidence of iritis varied from 1.4 to 6 per cent.

Postoperative Ablatio Retinae.—It is improbable that the type of suture has any effect on the incidence of postoperative detachment of the retina. This is determined by factors present before the operation, such as predisposition; accidents which occurred during the operation, such as loss of vitreous, and changes which occurred in spite of the suture after the operation, such as adhesion of the vitreous to the wound. The important, and unsettled, question is whether the intracapsular or the extracapsular method is followed more often by detachment. This is not the subject of this paper. Detachment of the retina occurred in 2 instances in the first series, in 3 instances in the second series and in none in the third series. In all 5 cases it

followed intracapsular extraction with no loss of vitreous. In Knapp's 500 cases of intracapsular extraction there were 6 instances of detachment, in only 1 of which it followed loss of vitreous. Hughes and Owens had detachment in 0.9 per cent of 1,720 extractions, both intracapsular and extracapsular, in which no vitreous was lost. However, as they convincingly proved, the incidence of detachment increases in proportion to the amount of loss of vitreous to reach 10.9 per cent after extractions with severe loss of vitreous.

Glaucoma.—It is generally accepted that incarceration or prolapse of the iris or the vitreous, iritis, hyphema of long duration—factors leading to partial blocking of the angle of the chamber—are usually responsible for postoperative glaucoma. Kronfeld and Haas [35] clearly proved that a single factor, the delayed formation of the chamber, can lead to enough peripheral anterior synechias to produce glaucoma in previously normal eyes. However, it is not known how much pathologic change is needed in a given case to upset the anatomic relations and the forces regulating the tension. The suture is instrumental in reducing all those factors mentioned which predispose to glaucoma. The various statistics in regard to this complication are hard to evaluate and to compare, because this type of glaucoma may manifest itself only several months, or years, later. Besides it usually does not cause pain; so the aged person does not seek medical aid in every instance. The usual statistical figure is between 1 and 3 per cent. In my first, second and third series the corresponding figures were 4 (2.6 per cent), 3 (2.0 per cent) and 0. In the first series there was prolapse of the iris in 2 cases, prolapse of the vitreous in 1 case and loss of vitreous during operation in 1 case. In the second series glaucoma existed before the extraction in 2 cases; in the third case there were loss of vitreous and loop extraction.

Dystrophy of the Cornea.—This complication of the cataract operation is rare. It is not amenable to any treatment and usually results in very poor vision or in blindness. Terry [36] set up five types of corneal changes which result in unsuccessful cataract operation. To group 4 belong "lesions arising through stimulation of degeneration or production changes resulting directly or indirectly from the operation, such as exacerbation of corneal dystrophy." Fuchs [37] found this condition in more acute form after irrigation of the anterior chamber, even when isotonic solution of sodium chloride was used. The slower-developing

35. Kronfeld, P. C., and Haas, J. S.: Glaucoma Due to Peripheral Anterior Synechia After Operation for Cataract, Arch. Ophth. **33**:199 (March) 1945.

36. Terry, T.: Unsuccessful Cataract Extractions, Arch. Ophth. **29**:862 (May) 1943.

37. Fuchs, E.: Erkrankungen der Hornhaut durch Schädigungen von hinten, Arch. f. Ophth. **92**:145, 1916.

type occurred when more than one operation had to be performed. The diffuse corneal haziness was superficial at first, and vesicles appeared; finally, a condition which he called sclerosis of the cornea, similar to epithelial dystrophy of the cornea developed. Fuchs made histologic examination in 10 such cases and observed lamellar layering on the anterior surface, swelling and wrinkling of the corneal lamella, hyaline degeneration and homogenous layering on the posterior surface.

In my first series there were 3 such cases, with none in the second and third series.

A typical case is that of Mrs. P. E., aged 79, who was first seen Feb. 10, 1939. In November 1938 she underwent a cataract operation on the left eye and, a few weeks later, two operations for glaucoma on the same eye. Vision was equal to counting fingers at 4 feet (120 cm.) in the right eye, and light perception and projection were good in the left eye. In the right eye there were a fine central corneal macula 2 mm. in diameter and diffuse blur of the nucleus of the lens. Tension was normal. The left eye was aphakic; the cornea was cloudy in the deep layers, and a vitreous hernia was touching the cornea. On Aug. 14, 1940, vision in the left eye was equal to light perception and light projection, and tension was +2. There was a deep ulcer of 2.5 mm. diameter in the center of the cornea; the chamber was one third filled with blood. The corneal ulcer cleared up. On May 20, 1943, intracapsular extraction was done on the right eye, with little pressure applied; the Verhoeff suture was employed; recovery was uneventful, but striate keratitis was pronounced. On July 10, 1943, vision in the right eye was 20/200 with correction. There was moderate haziness in front of Descemet's membrane in the central portion of the cornea. Instillation of an ointment containing 5 per cent ethyl morphine hydrochloride and warm packs were ordered. The haziness became deeper, and by Aug. 8, 1945, vision had fallen to counting fingers at 2 feet (60 cm.). The cornea became stippled and hazier, with gradual involvement of the anterior layers, and an occasional vesicle and bulla caused severe pain. Removal of the epithelium and treatment with zinc sulfate, 0.5 per cent, for two minutes was effective against the recurrence of the bullous keratitis. Tension in the left eye remained normal all the time. In this case corneal dystrophy followed the cataract operation in both eyes. It can be assumed that this patient had a predisposition to dystrophy.

I observed this condition in a total of 5 eyes in 4 patients in the course of 500 extractions. In 1 patient (see preceding paragraph) it developed in both eyes; in the other 3 patients, in one eye. The probable contributing factors were old central macula; prolapse of the iris, with attempted reposition and excision; prolonged massage to remove cortical matter, and two operations for glaucoma following the extraction. In all cases there were numerous folds in Descemet's membrane, and the corneal opacity started in the deep layers and gradually advanced toward the epithelium. Finally, in one-half to two years, the epithelium became involved and vesicles appeared. Glaucoma developed later in 1 case.

From this experience with postoperative dystrophy of the cornea, it is evident that it occurs in eyes which either show a visible pathologic

process of the cornea or, as Fuchs and Terry suggested, have a latent predisposition to dystrophy, which becomes evident after the eyes have undergone more than one operation. In most cases probably there is damage to the endothelium and Descemet's membrane, either direct or indirect. To quote Kirby,[38] "If healing of the breach [in the endothelium] does not occur, dystrophy and bullous keratitis may develop."

It does not seem probable that the use of any type of suture has a prophylactic influence on this condition. It should be noted, however, that in all my 3 cases there was no conjunctival flap. Is this a contributing factor to the dystrophy because of poorer nutrition of the cornea?

Expulsive Hemorrhage.—Expulsive hemorrhage, with so much preoperative precaution, is rare nowadays. It is fair to assume that late expulsive hemorrhage, which occurs several hours or days after the operation, is prevented by the deep suture. In the prophylaxis of another late complication, changes in the vitreous, which is secondary to loss of vitreous, I should not attempt to determine the value of the suture.

TABLE 3.—*Visual Results*

Series	Visual Acuity				Number of Cases with Preoperative Complications Which Were Omitted *
	20/15 to 20/30	20/40 to 20/70	20/100 to 20/200	Less than 20/200	
First	118 91.5%	6 4.7%	0	5 3.8%	21
Second	112 90.3%	8 6.5%	0	4 3.2%	26
Third	30	1	0	0	4

* However, in about one half of these cases normal vision was regained.

VISUAL RESULTS

The visual results (table 3) can be correctly compared only if the cases with extraneous causes of reduced vision are excluded. There were 21 such cases in the first series, 26 in the second series and 4 in the third series. These were cases of corneal scar, conical cornea, changes due to uveitis, various types of retinopathy, senile macular degeneration, severe myopic changes in the fundus, amblyopia and glaucoma.

In the first paragraph of this paper the statement was made that the postoperative infection is second in importance to the other types of postoperative complications. How does this statement hold in the light of my 335 cases, which number includes all cases of complicated cataract? Final vision was less than 20/200 owing to iritis in 3 cases;

38. Kirby, D. B.: Prevention and Handling of Complications Arising During and After Cataract Extraction, Arch. Ophth. **25**:866 (May) 1941.

1 of these eyes was enucleated. Vision was less than 20/200 as a result of retinal detachment or of corneal dystrophy in 3 cases each, and of glaucoma, of condensation or of blue vitreous in 1 case each; i. e., vision was less than 20/200, definitely poor, as a result of operative or postoperative complications of inflammatory nature in 3 cases and of a noninflammatory nature in 8 cases.

SUMMARY

Use of deep sutures in cataract operations is a great step forward in eliminating certain complications. The preplaced appositional corneoscleral suture, combined with a conjunctival flap covering the wound, is considered the best method. A modification of the McLean suture is described which eliminates the difficulty of making the wound in the presence of a prepared conjunctival flap. One or two sutures can be used. A series of 150 unselected cases of cataract extraction with use of the Verhoeff suture, method A, and a second series of 150 cases of extractions with use of the new suture are compared as to postoperative complications, degree of astigmatism and final visual results. In a third series, of 35 unselected cases, two sutures were used. Complications and results obtained by other authors using deep sutures and those in two series with the use of conjunctival sutures are tabulated.

It was found that the new suture was superior to the Kalt-Verhoeff suture in the rapid and solid closing of the wound, thus keeping low the incidence of shallow and flat chambers, wound rupture and postoperative prolapse of the iris and vitreous. However, in this respect it was not better than the original McLean suture; it was only easier to carry out. The postoperative astigmatism was about 0.3 D. higher than it was with the McLean suture. When two sutures were used, the astigmatism was about the same as that with two McLean or three appositional sutures.

The visual results compare favorably with the statistics of other authors. In both series of extractions 20/30 vision or better was obtained in 90 per cent of the cases of uncomplicated cataracts. Among the late postoperative complications, detachment of the retina and corneal dystrophy are believed not to be reduced by the suture. The latter condition occurred only in cases in which no conjunctival flap was made. The incidence of glaucoma is reduced indirectly by the suture through reduction in the complications of closure of the wound. However, this has not been shown by my figures. With careful preparation and the intracapsular technic, employment of deep sutures and use of the sulfonamide drugs or penicillin, the postoperative infection is less often the cause of poor results than are the other postoperative complications taken as a group.

Old National Bank Building.

OCULAR INVOLVEMENT IN RATS ON DIETS DEFICIENT IN AMINO ACIDS

I. Tryptophan

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AND
LEON ROIZIN, M.D.
With the Technical Assistance of Mr. Morgan Worthy
NEW YORK

OCULAR involvement and cataractous changes in the lens have been reported under a great number of experimental conditions (tetany; diabetes, including galactose and xylose cataract; thallium intoxication; riboflavin deficiency) and clinically in association with various cutaneous diseases, as well as with mongolism and myotonia.[1]

More recently, blindness with opacities of the lens was described by Curtis and associates,[2] and cataractous changes in the lens with vascularization of the cornea were reported by Totter and Day,[3] Albanese and Buschke [4] and Buschke [5] in rats on tryptophan-deficient diets.

During the past four years we have been studying the effects of various amino acid-deficient diets on the growth, development, morphology of various body tissues and organs, endocrine glands and nervous system in rats. Up to the present we have observed ocular involvement with diets deficient in tryptophan and valine.

Read at a meeting of the New York Society for Clinical Ophthalmology, May 7, 1945.

From the Department of Neuropathology, New York State Psychiatric Institute and Hospital.

1. Buschke, W.: Dystrophic Cataracts and Their Relation to Other "Metabolic" Cataracts, Arch. Ophth. **30**:751 (Dec.) 1943.

2. Curtis, P. B.; Hauge, S. M., and Kraybill, H. R.: The Nutritive Value of Certain Animal Protein Concentrates, J. Nutrition **5**:502, 1932.

3. Totter, J. R., and Day, P. L.: Cataract and Other Ocular Changes Resulting from Tryptophane Deficiency, J. Biol. Chem. **140**:136, 1941.

4. (*a*) Albanese, A. A., and Buschke, W.: On Cataract and Certain Other Manifestations of Tryptophane Deficiency in Rats, Science **95**:584, 1942. (*b*) Albanese, A. A.: Corneal Vascularization in Rats on Tryptophane Deficient Diets, ibid. **101**:619, 1945.

5. Buschke, W.: Classification of Experimental Cataracts in the Rat: Recent Observations on Cataract Associated with Tryptophan Deficiency and with Some Other Experimental Conditions, Arch. Ophth. **30**:735 (Dec.) 1943.

In rats on a tryptophan-deficient diet we were able to confirm and to extend the observations of some of the aforementioned authors.[6] In the present paper, particular attention will be paid to the development and the histologic character of the cataractous changes in the lens associated with this deficiency.

EXPERIMENTAL PROCEDURE

In all, 89 young (45 to 55 Gm.), adult (100 to 120 Gm.) and older (200 Gm.) albino rats of the Sherman strain, of the same litter and sex (male), were used in these experiments.

The animals were separated into four groups. The first group of rats was fed a tryptophan-deficient diet as suggested by Albanese and co-workers except that (1) the vitamin mixture was administered according to the method of Riess and Block and (2) the salt fixture was prepared according to Huvell and associates.[7]

The other three groups of rats, used as controls, were divided as follows: Group 2 was fed the same tryptophan-deficient diet as the rats in group 1, modified only by the addition of synthetic tryptophan from the beginning of the experiments; group 3 was maintained on the tryptophan-deficient diet until definite signs involving the ocular structures were apparent, and then synthetic tryptophan was added to the diet; group 4 was fed a standard normal diet for rats (Rockland's rat pellets) to which hydrosoluble and liposoluble vitamins were added in the same amount and form.

Two additional control groups of rats fed with a tryptophan-deficient diet supplemented with excess of vitamin A and riboflavin, respectively, were also used. These controls were intended to eliminate the possible influence of vitamin deficiencies in determining the cataractous changes.

The rats were killed with ether at various stages of the experimental investigation. Some were maintained alive for about eighteen months and then killed. However, some died unexpectedly. Autopsy was performed immediately after death, and the tissues were fixed by microinjection technic with a 5 per cent concentration of solution of formaldehyde U. S. P. in isotonic solution of sodium chloride or in 80 per cent alcohol. For the histologic studies of the lens, pyroxylin embedding was used, and serial sections were stained with hematoxylin and eosin, the Van Gieson stain and the Masson method.

EXPERIMENTAL OBSERVATIONS

Most of the animals on tryptophan-deficient diets disclosed, in various degrees, arrest of growth, loss of body weight, changes in the general appearance (hunched posture), disappearance of the subcutaneous adipose tissue, pronounced pallor of the skin and visible mucosa, alteration of fur (thinning, fragmentation and alopecia), artophy of the gonads and, at times, yellowish coloring of the incisor teeth with alteration of the enamel.

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6. Totter and Day.[3] Albanese and Buschke.[4a] Buschke.[5]

7. Details on diets will be reported in a subsequent paper, dealing with histologic changes in various organs occurring with tryptophan-deficient diets.

The ocular changes, in order of their appearance, may be described as follows: Pronounced superficial vascularization of the cornea, at times followed by or associated with spectacle eyes. The latter was characterized by complete loss of fur on the eyelids and, to a less extent (fig. 1 *A*), extreme edema and congestion of the eyelids (fig. 1 *B*); conjunctivitis, and the presence of catarrhal and mucous secretion around the eyelids, causing at times adherence and complete occlusion of the eyelids (fig. 1*C*) unless treated with a medicamentous or saline solution. These changes appeared four to six weeks after the beginning of the experiments in the younger animals (45 to 55 Gm.).

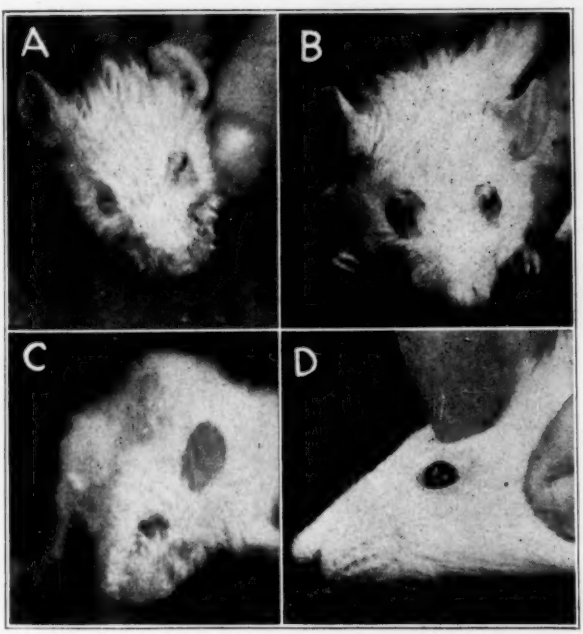

Fig. 1.—*A* and *B*, extreme edema of the eyelids and spectacle eyes; *C*, adherence and complete occlusion of the eyelids, due to catarrhal secretion; *D*, normal control rat.

In the more developed animals, weighing 100 to 120 Gm. (at the beginning of the experiments), gradual development of opacities of the lens was noticed within five to eleven weeks after the beginning of the experiments (figs. 2 and 3).

During the lifetime of the animals Dr. Isadore Givner examined all the eyes with the slit lamp, both before the rat was placed on the deficient diet and weekly thereafter. In addition, the eyes were explored with the binocular loupe and with the ophthalmoscope for details of the fundus. All eyes were dilated to the maximum with a 1 per cent

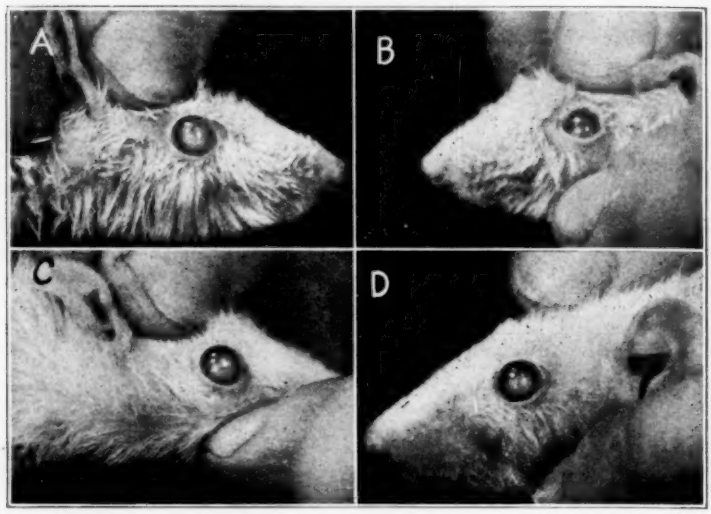

Fig. 2.—Opacities of the lens in different rats.

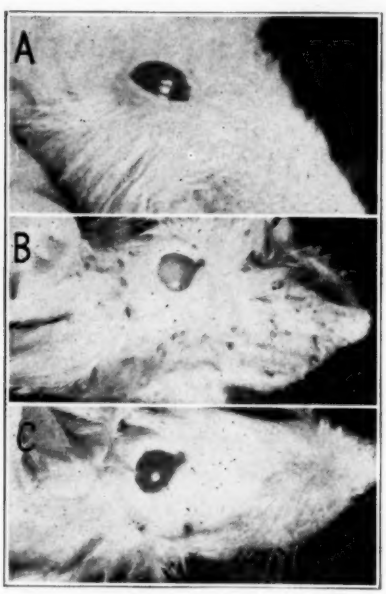

Fig. 3.—*A*, early changes in transparency of the lens; *B*, complete cataractous changes in the lens; *C*, lens of a normal control rat.

solution of homatropine hydrobromide. Ophthalmoscopic examination revealed "some cataractous changes," at times involving only one eye and at others both, although always in various degrees. It seemed that the variability was not alone the expression of individual susceptibility

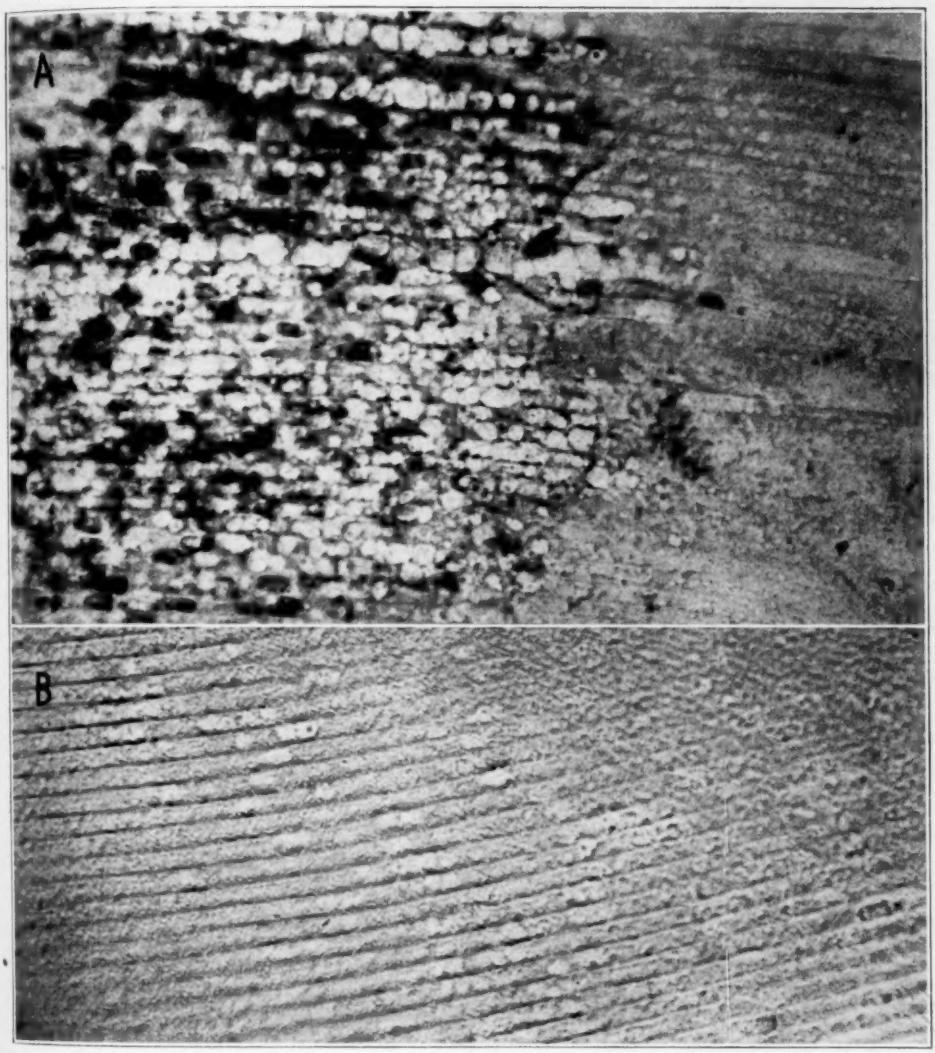

Fig. 4.—*A*, vacuolar degeneration of the lens fibers; *B*, section of the lens of a normal control rat. Hematoxylin-eosin stain; medium power magnification.

to the pathologic process of rats of the same litter, inasmuch as variability was noticed in the eyes of the same animal when both were involved.

In general, approximately 65 to 70 per cent of the animals disclosed various types and degrees of cataractous changes in the lens.

Microscopic studies revealed that some of the earlier changes involved more frequently the cortex of the lens. At this stage they consisted mostly of water splitting of the lens fibers and vacuolar formations, which at higher magnification were seen clearly, usually within the fibers themselves (fig. 4*A*). The vacuoles were often numerous and closely pressed together, so that the structure resembled a threadlike alga or degenerating myelin in nerve fibers.

At later stages severer morphologic changes, leading at times to complete degeneration and disintegration of the lenticular structures, were observed. These changes involved to different degrees the various parts of the lens, such as the cortical, the perinuclear or the nuclear, or various combinations of these (figs. 5*A*, *B*, *C* and *D*). While at times

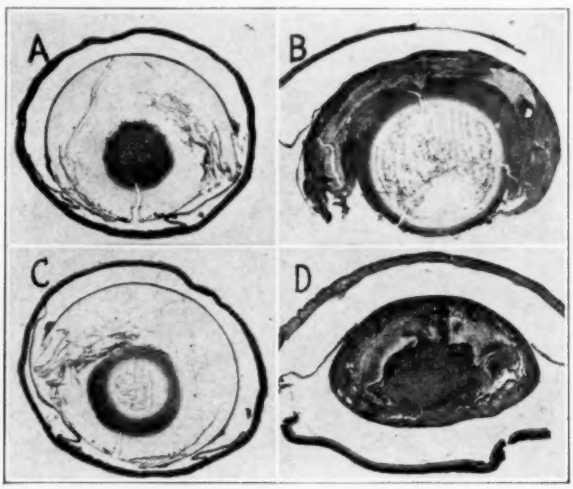

Fig. 5.—*A*, *B*, *C* and *D*, cataractous changes involving, in various degrees, different parts of the lens, as described in the text. *A* and *C*, Van Gieson stain; *B* and *D*, hematoxylin-eosin stain; low power magnification.

the morphologic alterations were distributed in layers, lamellas or more or less concentric or patchy formations (fig. 6*A* and *B*), in other instances complete disorganization and disruption of the histologic structure were evident (fig. 7*A* and *B*).

In group 3 the rats were maintained on a tryptophan-deficient diet until definite signs involving the various ocular structures were apparent, and then synthetic tryptophan was added to the diet. Within two to four weeks after administration of the synthetic tryptophan, gradual improvement in the general condition of the animal, new growth of fur in the alopecic areas, progressive gain in weight and slow increase in size of the gonads to an almost normal appearance were noted.

Concomitantly, some of the ocular manifestations improved considerably: The spectacle eyes and conjunctivitis disappeared in three to four and a half weeks, and the external appearance of the eyelids and eyes assumed that of the control animals (figs. 8 and 9). The vessels of the cornea narrowed and became empty of blood, and some were

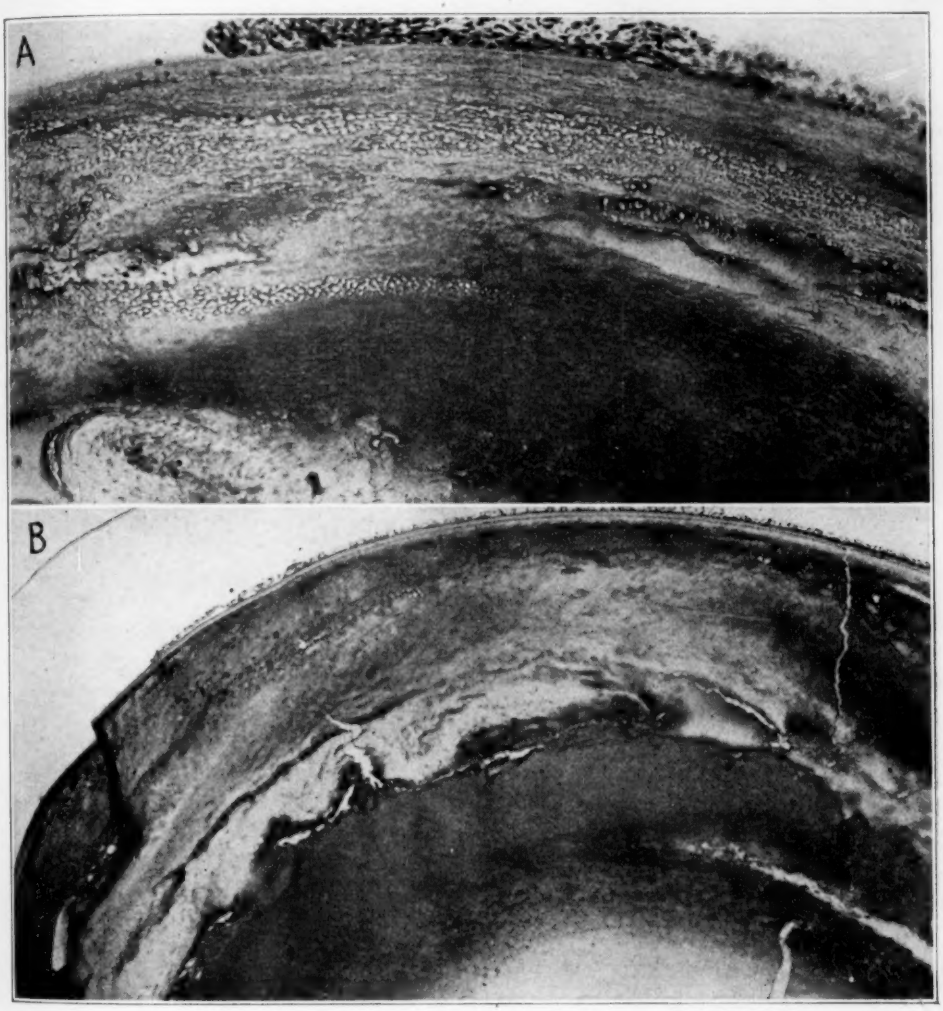

Fig. 6.—Distribution of the morphologic alterations of the lens in (*A*) lamellas and (*B*) concentric-like formations. Hematoxylin-eosin stain; medium power magnification.

found only with the aid of transillumination. The cataractous changes improved, and in some cases the water splitting of the anterior or the posterior cortex or of both disappeared completely. Examination with

the slit lamp showed that opacification was definitely less, and with the ophthalmoscope details of the fundi could be visualized which could not be seen before the addition of synthetic tryptophan to the diet.

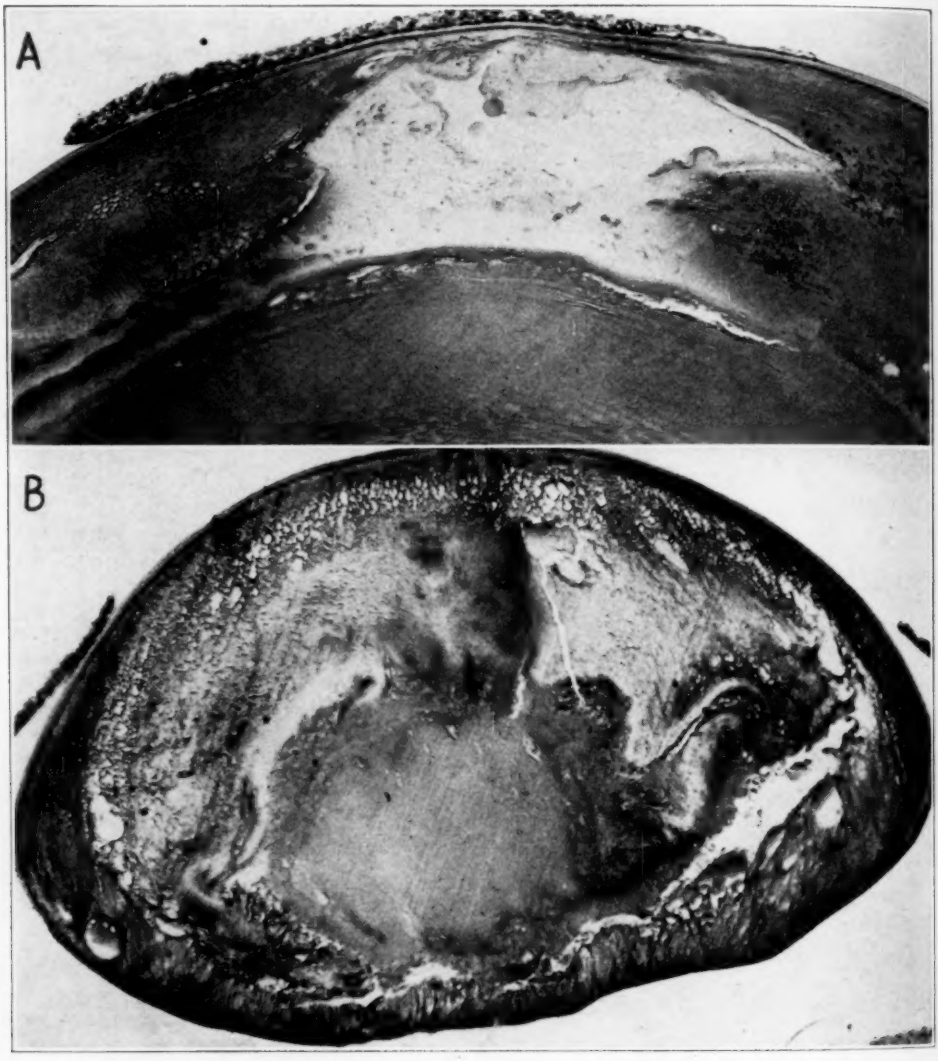

Fig. 7.—(*A*) large patch and (*B*) total disorganization of the histologic structure of the lens. Hematoxylin-eosin stain; low power magnification.

However, some of the more advanced cataractous changes (approximately at the stage illustrated in figures 5, 6 and 7) did not react favorably. In some cases the improvement was slight, and in others it did not occur at all. In animals in which definite cataractous changes

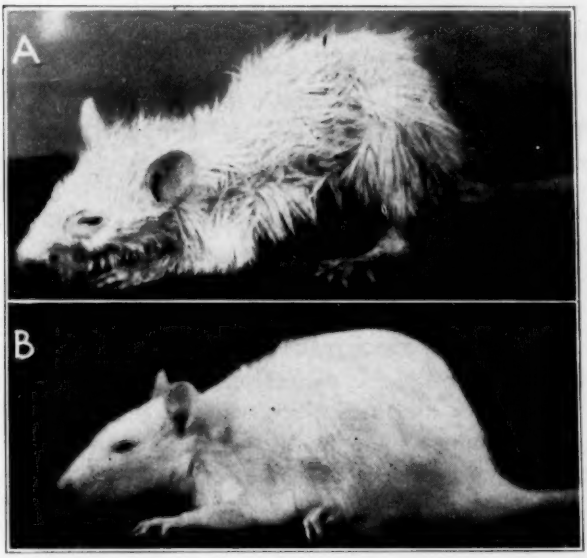

Fig. 8.—*A*, rat presenting the characteristic changes of general deficiency and spectacle eyes; *B*, the same animal five weeks after administration of synthetic tryptophan.

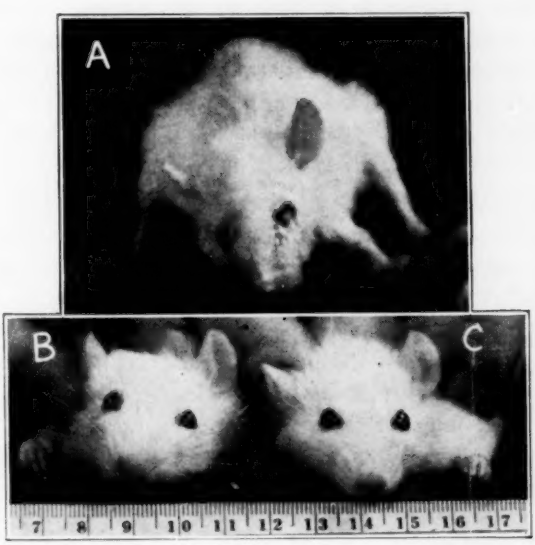

Fig. 9.—*A*, animal presenting the general and ocular signs of tryptophan deficiency; *B*, the same rat five weeks after administration of synthetic tryptophan; *C*, normal sibling, control animal.

were allowed to develop for six to eight weeks, the addition of the tryptophan to the diet was without effect, and progression continued even when the dose of added tryptophan was increased to twice, two and in 1 case to four times, the amount used with the control animals. It is interesting to note that with the addition of tryptophan all other signs of tryptophan deficiency completely disappeared.

One animal was maintained on a tryptophan-deficient diet until it presented definite cataractous changes (controlled with ophthalmoscopic examination) for a period of four weeks; then tryptophan was added to the diet until the general condition and the ocular involvement definitely improved. At that time the animal was put back on a tryptophan-deficient diet until the signs of tryptophan deficiency reappeared. These were subsequently successfully treated except for the cataractous changes. Five times the rat was placed on a deficient diet, and five times recovery permitted the animal to see it through.

On one occasion the same animal was maintained on a tryptophan-deficient diet for three weeks; then, instead of tryptophan, another amino acid was added (*dl*-lysine) to the deficient diet. Even double amounts (proportionally calculated) of this amino acid did not result in beneficial effect, but soon after tryptophan was added to the diet improvement was striking except for the cataractous changes. This animal, after a year of experimentation, presented extreme cataractous changes of the lens, which finally remained stationary. At that time tryptophan was added in double amount, and the rat was maintained on this unchanged diet for another year. During this period the cataracts did not change visibly, and at the end of the second year the animal was killed. Histologic studies indicated the presence of pronounced cataractous changes.

COMMENT

Our experiments confirm, extend and complete some of the previous observations by Totter and Day,[3] Albanese and co-workers[4b] and Buschke[5] on rats maintained on tryptophan-deficient diets.

The ocular changes, in order of their appearance, may be described thus: 1. In younger animals (weighing 45 to 55 Gm.) there appeared spectacle eyes, conjunctivitis, superficial vascularization of the cornea and occasionally cataractous changes in the lens. This group of animals did not resist for long on the deficient diet and generally died before presenting the more specific symptoms of tryptophan deficiency, noticeable to a greater degree in the next group. 2. In more developed rats (weighing 100 to 120 Gm.) spectacle eyes were apparent at times, but less frequently and to a less pronounced degree than in younger group. However, corneal vascularization and, particularly, various degrees of cataractous changes in the lens were more constant. The latter type of alteration was more frequently noted in this group of rats than in

the first, or even the third. 3. In a third group, that of adult rats weighing 200 Gm. at the beginning of the experiment, spectacle eyes and conjunctivitis were only occasionally noted, whereas vascularization of the cornea was more commonly observed.

We feel, therefore, that the cataractous changes in the lens developed more frequently (in our strain of rats) immediately before the rats reached the adult stage, when the young albino rats weighed approximately 100 to 120 Gm. at the initiation of the experiment.

Whether or not any of the pathologic changes in the ocular structures just reported were caused primarily by the lack of tryptophan, or whether they were secondary to lesions elsewhere in the body, cannot be decided at present, since our histologic studies of all the other organs and endocrine glands are not yet completed. However, it is established that tryptophan is able to prevent, improve and cure the general clinical, as well as some of the ocular, symptoms produced experimentally by tryptophan-deficient diets. These changes are of two types: (*a*) the earlier ones, characterized chiefly by water splitting of the lens fibers and vacuolation, changes which our experiments have established to be reversible under tryptophan treatment, and (*b*) the more advanced ones, leading to disorganization of the structure of the lens, changes which seem to be irreversible.

We feel that the clinical manifestations cannot be secondary to partial inanition or starvation or to a vitamin deficiency because control animals in partial starvation and supplied with the same amount of hydrosoluble and liposoluble vitamins as those used with tryptophan-deficient animals did not present any of the aforementioned pathologic changes.

Further comparative clinicopathologic studies may enlighten us concerning the important question whether any of the experimental ocular alterations described have any relation to similar changes observed in pathologic conditions in man.

150 East Ninety-Third Street

OCULAR CHANGES IN RATS ON DIETS DEFICIENT IN AMINO ACIDS

II. Corneal Dystrophy Due to Valine Deficiency

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AND

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With the Technical Assistance of Morgan Worthy

NEW YORK

OSBORNE and Mendel [1] were among the first investigators to demonstrate experimentally that some amino acids, although required only in a minimum amount, are essential to the life and development of animals. Their experiments were later confirmed by various authors, particularly Rose [2] and co-workers,[3] who established more definitely that of the twenty-two most important amino acids ten are absolutely essential to growing animals and eight are necessary for the maintenance of the nitrogen equilibrium in adult man. However, not enough attention was paid to possible structural involvement of the various tissues and organs in the absence of the specific amino acids. In more recent papers, Albanese and co-workers,[4] Buschke,[5]

Read at a meeting of the New York Society for Clinical Ophthalmology, March 4, 1946.

From the Department of Neuropathology, New York State Psychiatric Institute and Hospital.

1. Osborne, T. B., and Mendel, L. B.: Amino Acids in Nutrition and Growth, J. Biol. Chem. **17**:325, 1914.

2. Rose, W. C.: The Significance of Amino Acids in Nutrition, in Harvey Lectures, 1934-1935, Baltimore, Williams & Wilkins Company, 1935, vol. 49, p. 65.

3. Womack, M., and Rose, W. C.: The Relation of Leucine, Isoleucine and Norleucine to Growth, J. Biol. Chem. **116**:381, 1936. McCoy, R. H., and Rose, W. C.: The Relation of Glycine and Serine to Growth, ibid. **117**:581, 1937. Gunther, K. J., and Rose, W. C.: The Relation of Alanine to Growth, ibid. **123**: 39, 1937. Rose, W. C., and Rice, E. E.: The Significance of the Amino Acids in Canine Nutrition, Science **90**:186, 1937.

4. (*a*) Albanese, A. A.; Holt, L. E., Jr.; Kajdi, C. N., and Frankston, J. E.: Observation on Tryptophane Deficiency Rats: Clinical and Morphological Changes in the Blood, J. Biol. Chem. **148**:299, 1943. (*b*) Albanese, A. A.; Randall, R. M., and Holt, L. E., Jr.: The Effect of Tryptophane Deficiency on Reproduction, Science **97**:312, 1943.

(Footnotes continued on next page)

Maun and associates [6] and we [7] reported various structural changes associated with diets deficient in tryptophan,[8] lysine,[6b] phenylalanine,[6a] leucine [6b] and histidine.[6c]

In the report on rats maintained on tryptophan-deficient diets,[7] two of us (A. F. and L. R.) discussed certain general structural changes, particularly of the ocular tissues, among which the most important were various cataractous changes of the lens and superficial vascularization of the cornea.

In this preliminary communication, we wish to report observations on rats reared on a valine-deficient diet. A detailed report of the diets, general clinical observations and histologic changes in other organs and their relation to other dietary deficiencies will be given in a subsequent paper.

EXPERIMENTAL PROCEDURE

In this investigation, 12 albino rats of the Sherman strain were used; 6 of them weighed 100 Gm. each; the other 6, 200 Gm. each. All the animals were of the male sex, were selected from the same litter and were of the same age and approximate weight.

The diets consisted of a completely synthetic mixture of all the essential amino acids, as described by Rose and Epstein, except for the vitamin mixtures, which were freshly prepared.[7]

There were three control groups of animals: (*a*) animals reared on the same synthetic amino acid–deficient diet, to which valine was added from the beginning of the experiment; (*b*) animals which were maintained on the same valine-deficient diet until definite structural changes appeared, at which stage valine was added to the diet for the purpose of studying the reversibility of the structural changes; (*c*) rats maintained on a normal diet (Rockland's rat pellets) supplemented with the same mixture of vitamins.

All four groups of rats (the deficiency group and the three control groups) were fed *ad libitum* except that in the deficiency group some of the animals were fed artificially toward the end of the experimental stage in order to prolong their life as long as possible.

The duration of the experiments was from two and a half to four and a half months.

The changes in the cornea were observed with the aid of the biomicroscope. The animals were killed at various stages of the experimental investigations. Some eyes were fixed in a 5 per cent concentration of solution of formaldehyde

5. Buschke, W.: Classification of Experimental Cataracts in the Rat: Recent Observations on Cataract Associated with Tryptophane Deficiency and with Some Other Experimental Conditions, Arch. Ophth. **30**:735 (Dec.) 1943; Dystrophic Cataracts and Their Relation to Other Metabolic Cataracts, ibid. **30**:751 (Dec.) 1943.

6. Maun, M. D.; Cahill, W. M., and Davis, R. M.: Morphologic Studies of Rats Deprived of Essential Amino Acids: (*a*) I. Phenylalanine, Arch. Path. **39**: 294 (May) 1945; (*b*) II. Leucine, ibid. **40**:173 (Sept.) 1945; (*c*) III. Histidine, ibid. **41**:25 (Jan.) 1946.

7. Ferraro, A., and Roizin, L.: Ocular Involvement in Rats on Diets Deficient in Amino Acids: I. Tryptophan, Arch. Ophth., this issue, p. 331.

8. Albanese and others.[4] Buschke.[5] Ferraro and Roizin.[7]

U.S.P. in isotonic solution of sodium chloride; the others were fixed directly in 80 per cent alcohol and embedded in pyroxylin. Hematoxylin and eosin and the Van Gieson and Masson trichrome stains were used for the histologic studies.

CLINICAL OBSERVATIONS

Two weeks from the beginning of the experiments the group of animals on valine-deficient diets began to lose weight. The external appearance and the general condition of the body changed progressively. Briefly, these changes consisted in modification of the fur (changes of color and falling off), easy fatigability, pallor of the skin and visible mucosa, hunched posture and disappearance of the subcutaneous fat tissue; in walking the majority of animals disclosed instability and incoordination of movements and, at times, loss of equilibrium, resulting in

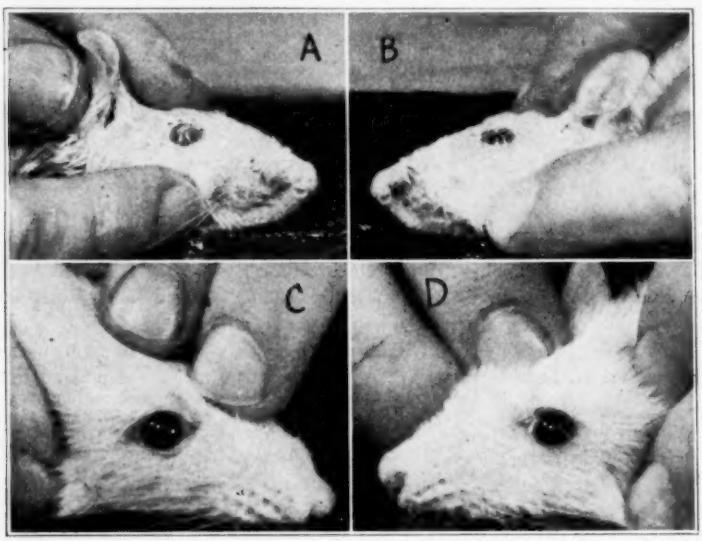

Fig. 1.—*A* and *B*, opacities of the cornea; *C* and *D*, normal appearance of the cornea in siblings of control rats.

falling. They also often disclosed a tendency to rotate in a circular manner and to extend the head in an upward vertical direction.

Clinically, the first ocular changes were noticed four and a half to five weeks after the beginning of the experiments. They consisted in a progressive lack of luster of the cornea followed by loss of transparency, due to edema and, as the condition progressed, by dryness of the cornea, involving chiefly the interpalpebral area (fig. 1).

In 1 case bullous keratitis developed in the interpalpebral portion, with edema of a mild degree involving the remaining cornea. The vascularization started as an arcade at the periphery and was consistently deep.

In advanced stages the corneal epithelium took on a dryness suggestive of xerosis, with desquamation of the superficial layers. The lens showed only slight changes, never sufficient to interfere with ophthalmoscopic studies. The changes were mostly water splitting and

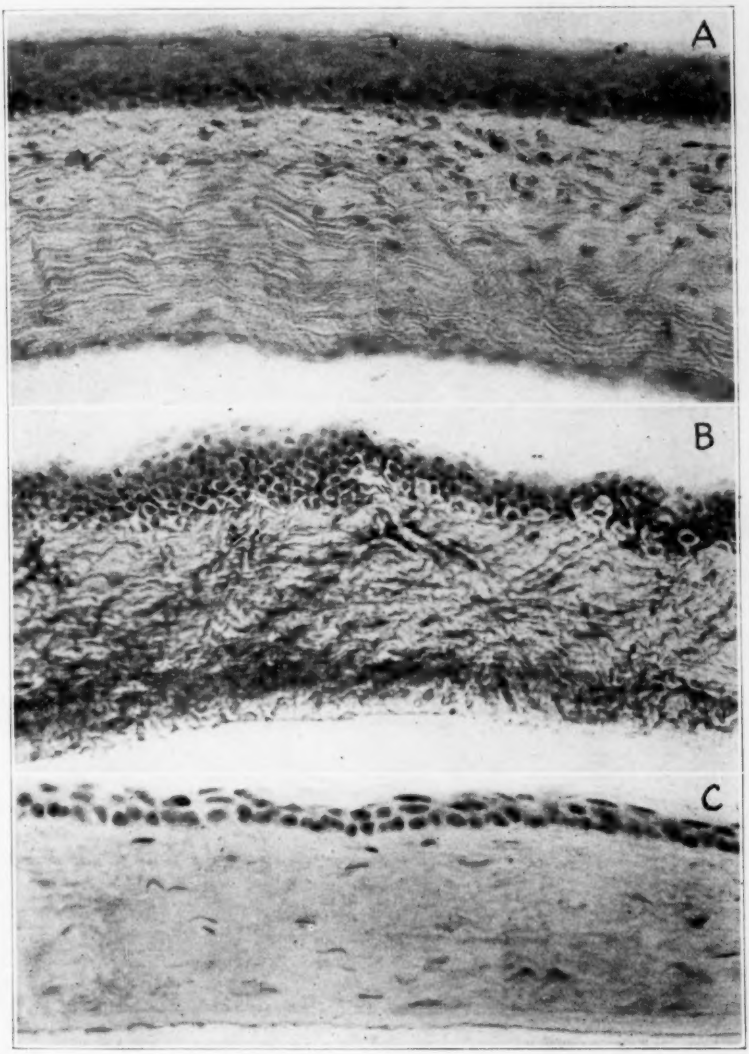

Fig. 2.—*A* and *B*, edema and early degenerative changes in the epithelial cells of the superficial layers of the cornea; *C*, normal histologic appearance of the cornea, of the control rat. *A* and *C*, hematoxylin-eosin stain; *B*, Van Gieson stain; low power magnification.

vacuolation in the anterior and the posterior cortex. The rest of the ophthalmologic studies showed a normal condition.

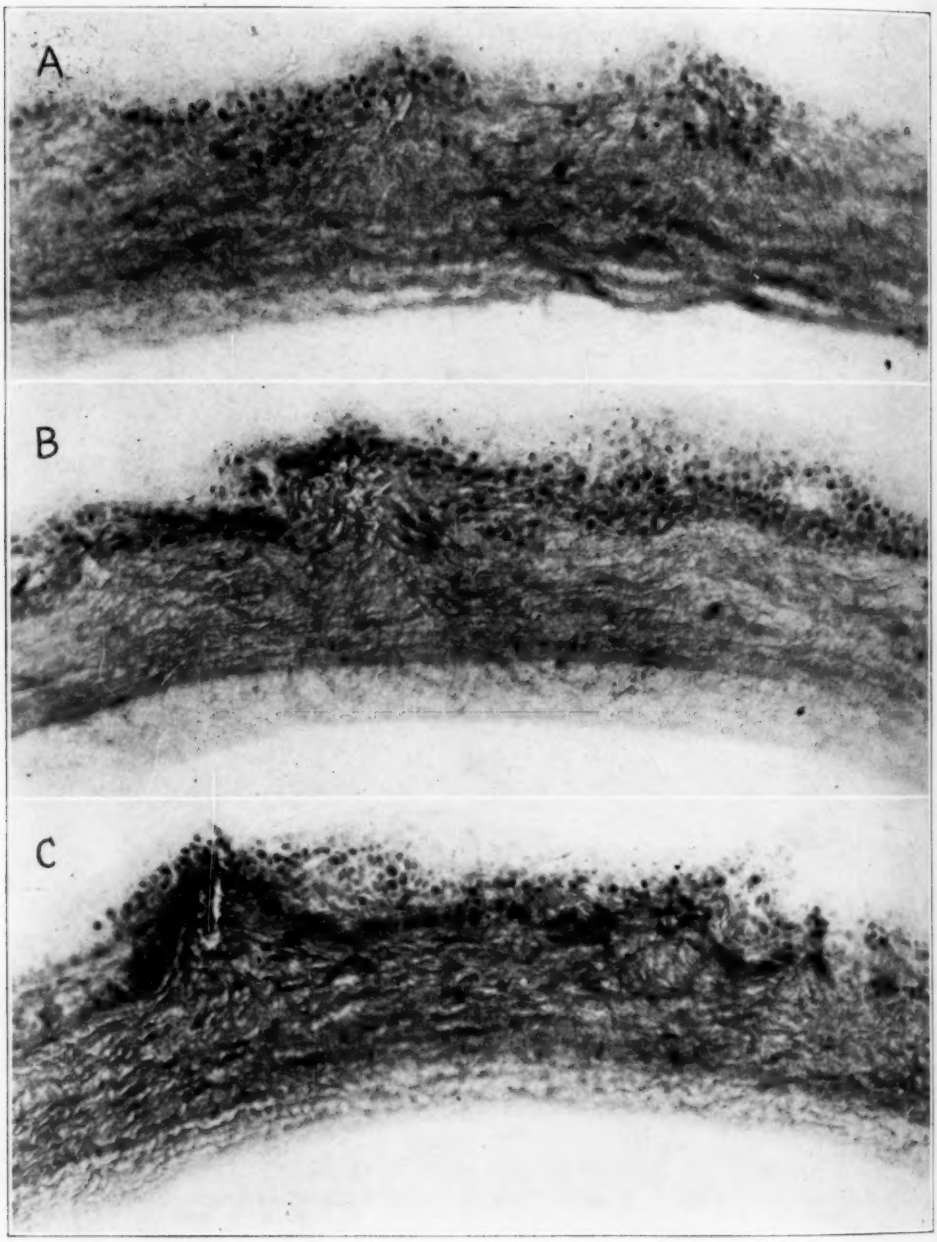

Fig. 3.—*A*, *B* and *C*, severer degeneration of the corneal epithelial cells of the cornea than that shown in figure 2, irregular stratification of the superficial layers, some keratinization and exfoliation. Hematoxylin-eosin stain; medium power magnification.

MICROSCOPIC STUDIES

Histologically, in the early stages of valine deficiency, edema and degeneration of the epithelial cells of the superficial layers of the cornea was noticed (fig. 2 *A* and *B*).

In more advanced stages the alterations were more pronounced, consisting of a more intense edema, severe degeneration of the various

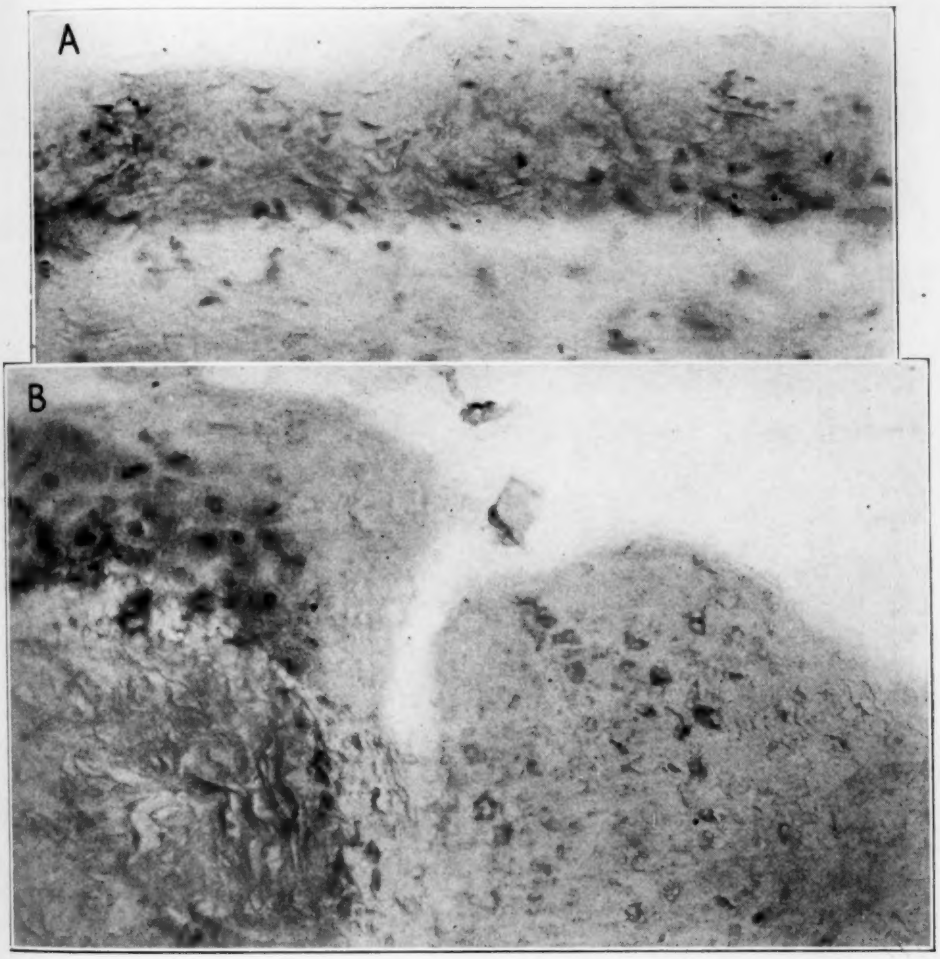

Fig. 4.—*A*, complete disorganization and keratinization of the cornea; hematoxylin-eosin stain, medium power magnification. *B*, higher magnification, illustrating severe changes. Hematoxylin-eosin stain.

epithelial cells, vacuolation of the protoplasm, displacement of the nucleus and, in certain areas, irregular stratification of the superficial layers, keratinization and exfoliation (fig. 3 *A*, *B* and *C*). These struc-

tural changes, although apparent mostly in the superficial layers of the cornea, at times involved also the basal epithelial layer, which in certain areas appeared completely disorganized.

In severer conditions all epithelial layers appeared almost completely disorganized and keratinized (fig. 4 *A*), and the tissue appeared cornified, with almost no signs of cellular structures. In other instances only

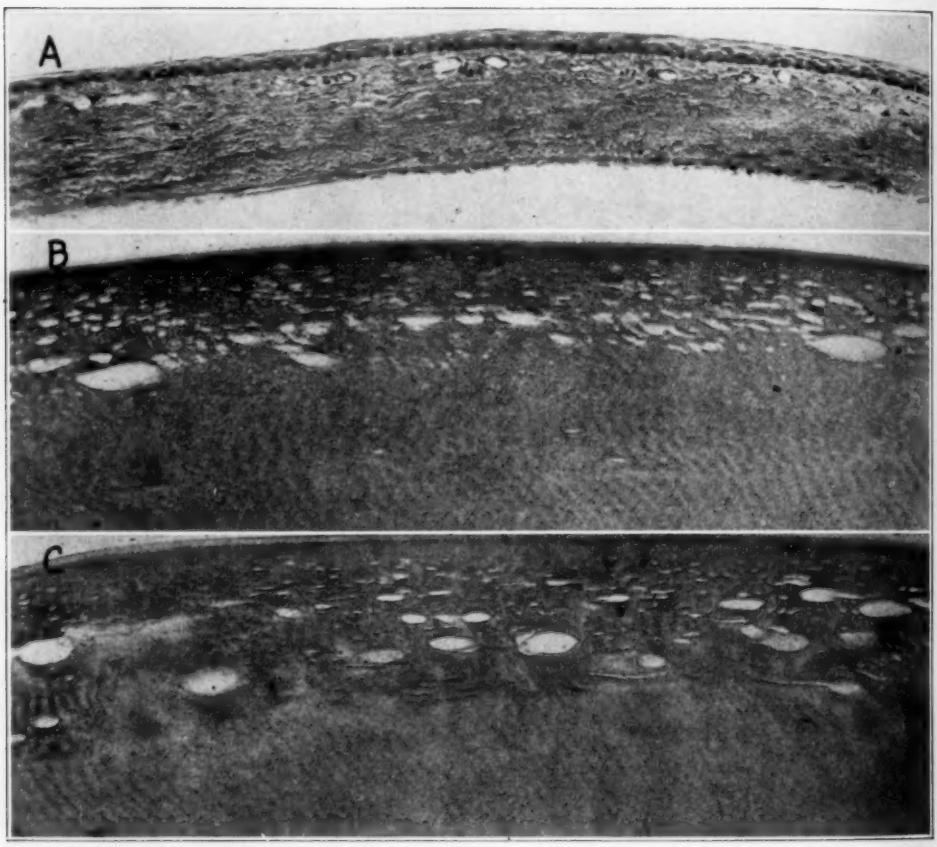

Fig. 5.—*A*, vascularization of the cornea; low power magnification. *B* and *C*, vacuolation of the cortical region of the lens; medium power magnification. *A* and *B*, hematoxylin-eosin stain; *C*, Van Geison stain.

shadow cells and some debris of disintegrated nuclei and cellular elements indicated the site of previous normal structures (fig. 4 *B*).

In addition, intense congestion and occasional diapedesis of the morphologic elements of the blood were detected. Proliferation of the blood vessels was also conspicuous (fig. 5 *A*). Occasional slight perivascular reaction of blood vessels of the surrounding stroma with mononuclear cells was encountered.

In 1 rat slight involvement of the lens was detected. It consisted mainly in vacuolation of the cortical region of the lens (fig. 5 *B* and *C*). It never progressed beyond this stage, in contrast to animals on trypto-

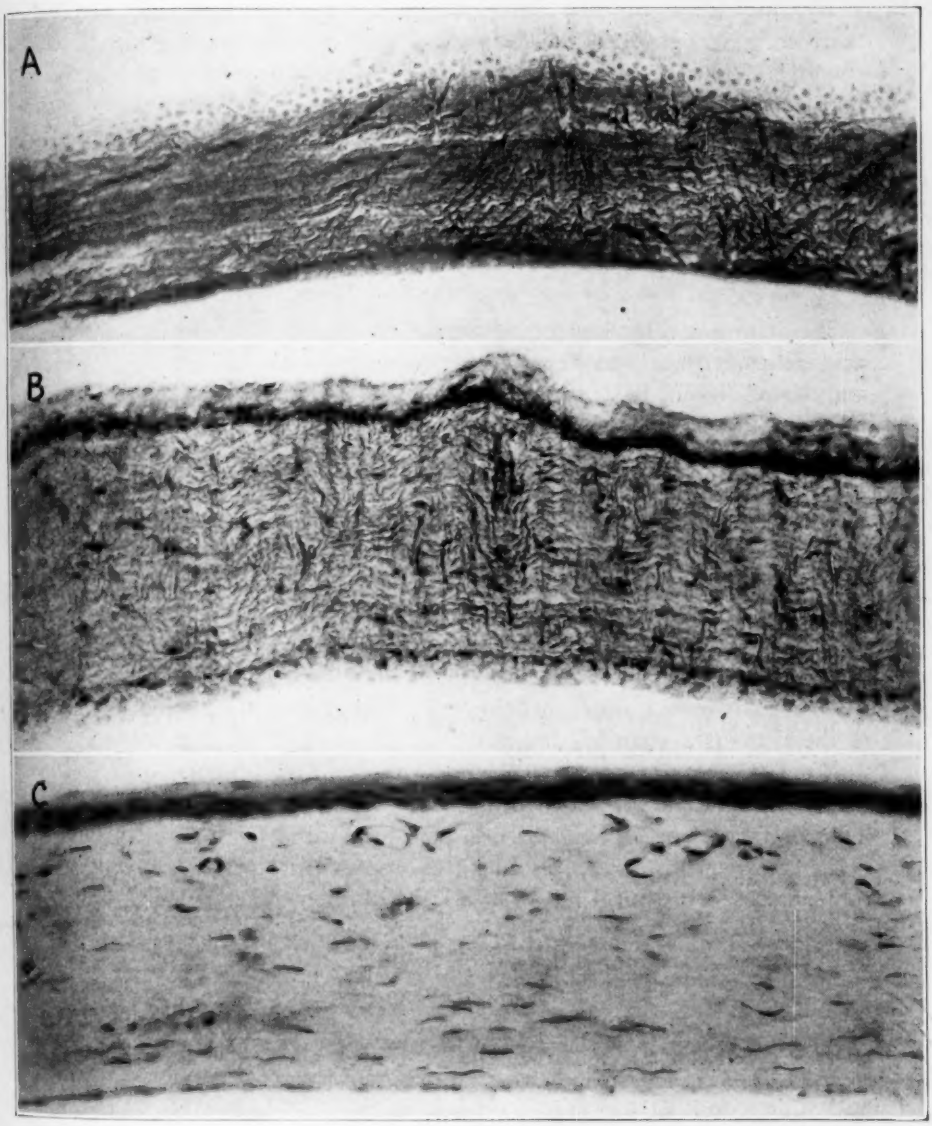

Fig. 6.—Less altered corneal structure, approaching a near-normal appearance; occasional presence of narrowed and mostly empty blood vessels (*C*). *A*, Masson trichrome stain; *B*, Van Gieson stain; *C*, hematoxylin-eosin stain. Medium power magnification.

phan-deficient diets, in which the process continued until complete cataractous changes of the lens had taken place.[7]

Shortly after administration of the synthetic valine to the animals on the valine-deficient diet in which corneal changes were noticed clinically, the edema gradually disappeared and the cornea assumed its normal transparency. The blood vessels of the cornea narrowed and were finally empty of blood cells. At the same time, the general appearance and nutrition of the animals gradually improved. Of these animals, 1 was killed five weeks and the other seven weeks after administration of the synthetic valine. Histologically, the structure of the cornea was much less altered, approaching a near-normal appearance (fig. 6 *A* and *B*). Here and there dilated blood vessels were still visible, but empty (fig. 6 *C*).

COMMENT

Structural involvement of the ocular tissues in rats receiving amino acid–deficient diets was reported for the first time by Curtis, Hauge and Kraybill,[9] in 1932, and later (1941) by Totter and Day,[10] who recorded the occurrence of cataract in tryptophan-deficient rats. More recently Albanese and co-workers,[4b] Buschke [5] and we [7] confirmed these observations while extending the investigation.

In 1939 Rose and Epstein [11] reported on the dietary indispensability of valine in rats. In their experiments these authors noted that the rats deprived of valine manifested peculiar symptoms, consisting particularly of extreme sensitiveness to touch, marked lack of coordination in movements, staggering gait and frequently "rotatory motion" in a clockwise or a counterclockwise direction. Whether this particular syndrome following valine deficiency is associated with specific lesions of the nervous system has not yet been determined.

In 1945 we repeated Rose's experiments (with minor modifications) with the purpose of investigating the possible structural involvement of various organs and tissues, particularly that of the central and peripheral nervous systems. In these experiments we were able to confirm Rose's [11] clinical observations; in addition, we noted the ocular alterations which are the subject of this discussion.

As already mentioned, the morphologic changes in the ocular structures in rats on valine-deficient diets consist mainly in a dystrophic change in the cornea as expressed by edema; various degrees of degeneration, chiefly of the superficial layers; hyperplasia of the epithelial

9. Curtis, P. B.; Hauge, S. M., and Kraybill, H. R.: The Nutritive Value of Certain Animal Protein Concentrates, J. Nutrition **5**:502, 1932.

10. Totter, J. R., and Day, P. L.: Cataract and Other Ocular Changes Resulting from Tryptophane Deficiency, J. Biol. Chem. **140**:136, 1941.

11. Rose, W. C., and Epstein, S. H.: The Dietary Indispensability of Valine, J. Biol. Chem. **127**:677, 1939.

elements, and, in the more progressed stages, complete keratinization of the cornea. Although these histologic changes were frequently more pronounced in the superficial layers, they involved also the deeper tissues. In addition, there were pronounced deep vascularization of the cornea and slight vacuolation of the cortical region of the lens. The last two changes differ distinctly from those observed in the rats on a tryptophan-deficiency diet: (*a*) In the rats given the valine-deficient diet involvement of the lens never progressed beyond the stage of initial vacuolation of the cortex, whereas in the rats given the tryptophan-deficient diet the progression was usually gradual until a more or less complete cataractous change in the whole lens had taken place; (*b*) in the rats on the tryptophan-deficient diet the vascularization of the cornea was superficial, whereas in the rat on the valine-deficient diet it was of deeper distribution.

Whether or not the corneal dystrophy is caused primarily by the lack of valine or is secondary to other metabolic disorders related to lesions elsewhere in the body cannot be decided at present, owing to the incompleteness of our histologic studies of the other tissues and organs. However, it is certain that valine is able to prevent, produce improvement in and cure the ocular symptoms produced experimentally in rats with valine-deficient diets.

The ocular involvement cannot be secondary to inanition or other dietary factors of the synthetic diets used, because the control animals given the same synthetic diet with the addition of valine, and living under the same experimental conditions, did not disclose any ocular changes.

It is interesting to mention that during the preparation of this paper Maun, Cahill and Davis [6b, c] reported structural alterations in various tissues and organs in rats maintained for twenty-eight days on diets deficient in leucine and histidine. The ocular involvement consisted in "thinning and stratification" of the corneal epithelium with keratinization of the surface. The substantia propria appeared thickened, but the structural pattern was well preserved. The vessels immediately beneath the corneal epithelium were dilated and prominent, and in a few instances scattered leukocytes were present in the perivascular tissue. The structure of the rest of the eye was normal.

That ocular changes associated with a valine-deficient diet did not attract the attention of other investigators may be due to the fact that our animals were maintained alive for a longer period, owing to forced nutrition at the stage when the animals were disinclined to eat spontaneously. A longer duration of the deficiency may have brought about advanced, and thus more noticeable, ocular changes.

CONCLUSION

In rats maintained on a valine-deficient diet changes develop in the cornea, in addition to general changes and structural alterations in other organs, which are still the subject of microscopic studies. The corneal changes seem to be the result of edema and progressive degeneration, leading gradually to keratinization and disorganization of the epithelial structure of the cornea. These changes are generally encountered in the interpalpebral space. In addition, pronounced deep vascularization of the cornea is observed. Slight changes in the lens, characterized chiefly by vacuolation of the cortex, are only occasionally noted.

These structural changes in the eye appear to be reversible (if treated in time), as demonstrated by notable improvement following the administration of synthetic valine to the animals on a valine-deficient diet.

The corneal changes appear as the most prominent feature of the ocular involvement. At the present stage of investigation we feel justified in naming the corneal change "nutritional corneal dystrophy."

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CATARACT COMPLICATING GLAUCOMA

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NEW YORK

CLINICALLY, cataractous lenses are encountered almost regularly in eyes with absolute glaucoma, especially those that are already aged. The symptoms of glaucoma and of cataract may merge into one another. Cataract in a glaucomatous eye progresses, no matter whether the tension has been kept down by a miotic or by operation.

The present paper, on cataract complicating glaucoma, is the sixth, and last, of a survey undertaken to record all microscopic changes that can possibly take place in the lens as a result of lesions in other structures of the globe. The papers already published dealt with cataracts associated with ulcers of the cornea,[1] scars of the cornea,[2] iridocyclitis,[3] detachment of the retina[4] and malignant tumors.[5] In these five papers, 154 cases of complicated cataract were studied and, as occasion arose, the influence of glaucoma as a secondary factor in the production of the cataracts was discussed. To this extensive and varied material are now added 31 cases of cataract that was believed to have been caused by glaucoma. This makes a total of 185 cases, illustrated with 61 drawings. Twenty of the 31 cases of the present paper represent primary glaucoma, mostly in the absolute stage. The remaining 11 cases represent secondary glaucoma. The effects of increased tension on parts of the eye other than the lens will be considered first.

THE RETINA

It was a striking fact that the retina in no less than one-half the cases of primary glaucoma showed a large amount of hemorrhage, often

Read at the Eighty-Second Annual Meeting of the American Ophthalmological Society, San Francisco, July 26, 1946.

1. Samuels, B.: Lesions in the Lens Caused by Purulent Corneal Ulcers, Tr. Am. Ophth. Soc. **39**:66-72, 1941.

2. Samuels, B.: Cataract Complicating Corneal Scars After Perforating Ulcers, Tr. Am. Ophth. Soc. **40**:292-304, 1942.

3. Samuels, B.: Pathology of the Lens in Non-Traumatic Iritis, Tr. Am. Ophth. Soc. **41**:262-272, 1943.

4. Samuels, B.: Complicated Cataract Associated with Spontaneous Detachment of the Retina, Tr. Am. Ophth. Soc. **42**:109-117, 1944.

5. Samuels, B.: Cataract Associated with Intraocular Tumors, Arch. Ophth. **35**:366-383 (April) 1946.

extending beyond the equator. It was evident that the interference with the venous circulation and the glaucoma were closely connected. In no instance could it be decided whether glaucoma had led to an obstruction in the venous outflow or whether an impediment in the latter had led to glaucoma. It is known that in cases of advanced glaucoma the sclerosed retinal artery may press on the retinal vein in the hiatus on the posterior surface of the lamina cribrosa. The different stages of interference with the retinal circulation determine the appearance of the fundus. Varicosities and newly formed blood vessels near the papilla indicate that there is incomplete interference with the venous outflow. These are signs that warn against operative intervention, because hemorrhage may take place from the thin-walled vessels and also because abnormal blood vessels in any part indicate a generally poor state of the whole globe. Massive hemorrhages following complete occlusion of the central vein are familiar to all. In 1 case of secondary glaucoma in this series, diagnosed in life as thrombosis of the central vein, the effects of occlusion of the vein on the general circulation, and indirectly on the lens, were clearly shown. The patient was 74 years old. The retina was hemorrhagic and atrophic. The shallow anterior chamber was filled with blood, and a hematogenous membrane covered the iris. The cataract was believed to have been hastened to maturity by toxins from decomposing red blood cells in the anterior zone. A rare clinical picture in absolute glaucoma is that in which no blood vessels, or only a few attenuated ones, are visible, owing to endarteritis obliterans in the main retinal artery.

THE IRIS

The state of a glaucomatous globe may be ascertained by a study of the anterior part of the uvea. As examples of hopeless conditions, the specimens showed necrosis of the iris, pathologic ectropion of the uvea and shrinkage of the whole iris. In 8 cases blood vessels on the anterior surface of the iris, which are merely endothelial tubes that rupture easily, even from a paracentesis, spoke against operative procedures.

THE CILIARY BODY

In practically all cases atrophy of the ciliary body was noted, and always without membrane on the surface which would have impeded the secretion of the aqueous. Atrophy of the ciliary body is commonly attributed to insufficient blood supply and altered metabolism. Necrosis of the ciliary processes, so frequently recorded in the paper on cataract associated with intraocular tumors, was rarely seen, proving that in cases of absolute glaucoma from necrotic tumor the necrosis is the effect of toxins.

CONDITION OF THE VARIOUS STRUCTURES OF THE LENS

The Capsule.—In a majority of the cases the capsule showed no folds. In 1 case deep folds were present, the result of contraction on the part of an anterior capsular cataract and a pupillary membrane. The fact that there was deep keratitis made it likely that the development of cataract had been hastened by iritis following an operation. In short, absence of folds in the capsule was considered to be typical and characteristic of the lens in cases of glaucoma.

Strictly speaking, 1 of the cases of absolute glaucoma (fig. 6) did not belong to the present survey, but because it showed the danger of touching the tense capsule in a glaucomatous eye it was included. Six weeks prior to enucleation the lens had been punctured by the needle of a syringe in an attempt to withdraw aqueous. The capsule

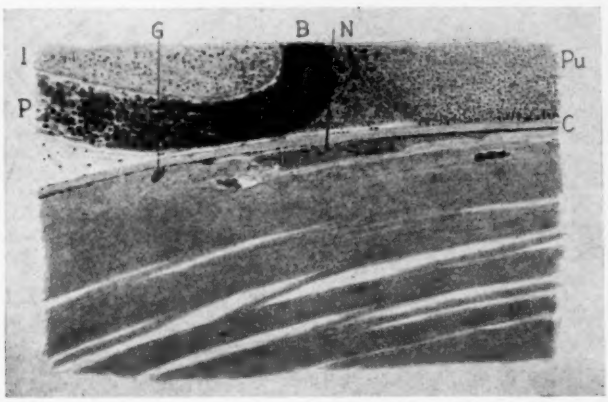

Fig. 1.—Hemorrhagic glaucoma in the eye of a man aged 54. Most of the lens, including the germinal zone, was in order. At *PU* the pupillary area is filled out by blood and fine pigment particles. The iris (*I*) is entirely necrotic, and the pigment epithelium (*P*) is broken down. At the pupillary border (*B*) a mass of nuclei (*N*) from desquamated cells appears under the capsule (*C*) in the liquefied cortex. To the left there are two buds of cells suggesting giant cells (*G*), which are due to localized proliferation of the capsular epithelium. Between (*G*) and (*N*) the epithelium is irregular and only acquires a normal appearance to the left of the picture. In the deeper zone there are two cavities, containing a brownish substance.

was absent over the entire anterior surface of the lens, having been stroked back by a mass of escaping and expanding lens matter. In nonglaucomatous globes a small rent in the capsule causes it to retract a little and to be thrown into folds, but, here, from the tiniest prick an enormous opening in the capsule developed to make way for the escape of expanding lens substance. Postoperative spontaneous rupture of the distended capsule is known to occur in cases of glaucoma when the lens is tilted and presents itself in the wound.

The Epithelium.—Concurrent with the smooth, and even overlying, capsule, the epithelium was as a rule well preserved, accounting for the rarity of an anterior polar cataract associated with glaucoma. In 1 instance (fig. 1) glaucoma had caused necrosis of the pupillary zone of the iris and this, in turn, necrosis of the underlying subcapsular epithelium. The epithelium adjoining the necrotic area proliferated in an effort to repair the damage. Prevented from doing this, it grew back on itself, forming a tuft of cells. Apparently, the subcapsular epithelium has the property of repairing defects similar to that of the endothelium of the cornea. It is not uncommon to see at the margin of a defect in the endothelium on Descemet's membrane a clump of cells which may be so large as to be visible with the naked eye. Such a formation may break off and float in the aqueous, or it may attach itself

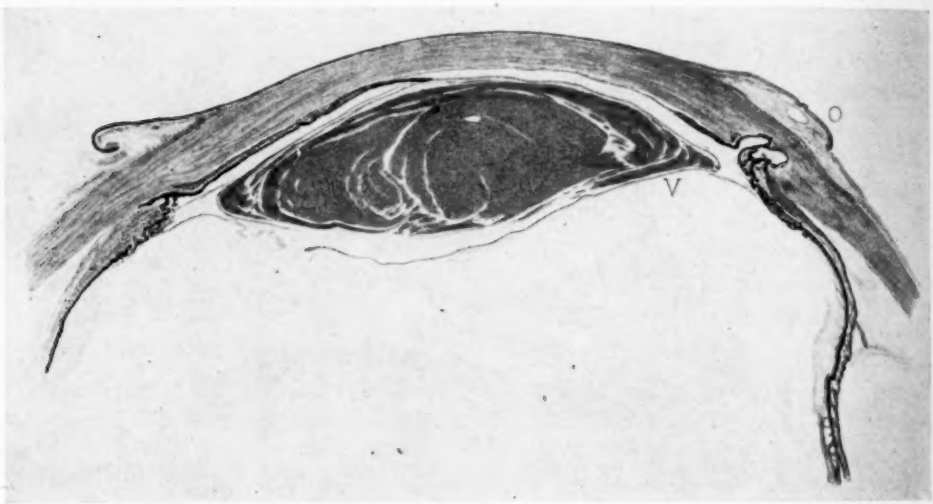

Fig. 2.—The eye of a man aged 47. An iridectomy for glaucoma had been performed three months before enucleation. The wound gapes and is outlined by a layer of pigment. The overlying conjunctiva is swollen and cystic (*O*). On both sides the thin and compressed iris lies against the cornea. The anterior chamber is abolished, the slitlike opening being an artefact. The vitreous (*V*) has pressed the lens forward, causing the posterior surface to be less convex than the anterior—the reverse of normal. The ciliary body is atrophic and compressed. A ciliary process is drawn into the wound.

to the iris and form an island of endothelial cells. In a similar way, the subcapsular epithelium may proliferate at the margin of a defect and form a nodule, which may cling to the capsule or float in the liquefied cortex.

The Germinal Zone.—The germinal zone, like the subcapsular epithelium, was not as a rule greatly damaged. Several times it was

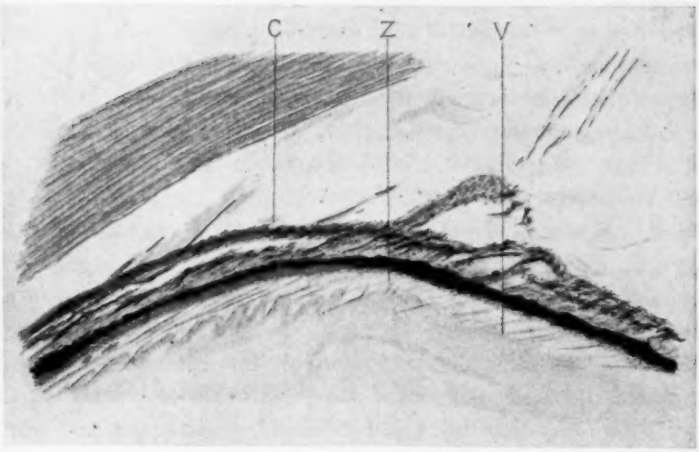

Fig. 3.—Detail of figure 2 taken from the flat part of the ciliary body (*C*). Sharp folds of the anterior limiting layer of the vitreous (*V*) project into the spaces between the zonular fibers (*Z*).

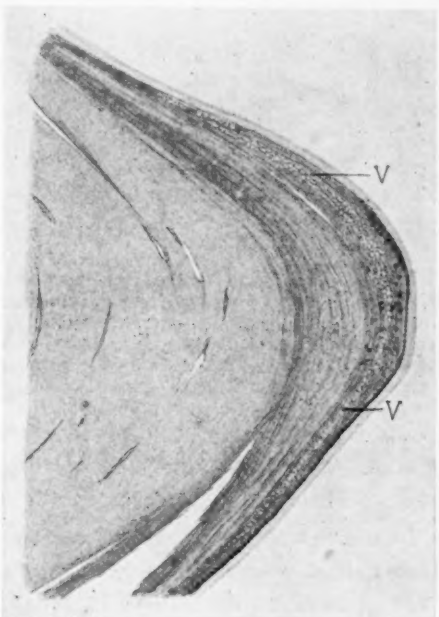

Fig. 4.—The eye of a man aged 66. Absolute glaucoma had led to shrinkage of the iris and formation of a membrane on it. In the drawing, the lenticular changes are minute and are restricted to the equator. They consist of a row of small vacuoles (*V*), which bisect the germinal zone, leaving intact lens fibers, with their nuclei on either side.

absent on one side but preserved on the other, just as the ciliary body may be atrophic in one sector and normal in the others.

Vesicular Cells.—Vesicular cells, when present, were noted only in small amounts. The scarcity of these cells was explained by the fact that in this glaucomatous group the cataracts were never as far advanced as in the cases of iridocyclitis and detachment of the retina, in which vesicular cells were numerous and characteristic.

The Lens Substance.—Disintegration and liquefaction of the lens substance, so frequently noted in the cataracts described in the previous papers, were seldom observed and therefore were not considered characteristic of glaucomatous cataract. In fact, in most instances the damage to the lens substance was relatively insignificant. Shrinkage of lens and folds in the capsule were rare and could always be explained by a condition other than increased tension. A shrunken lens would be

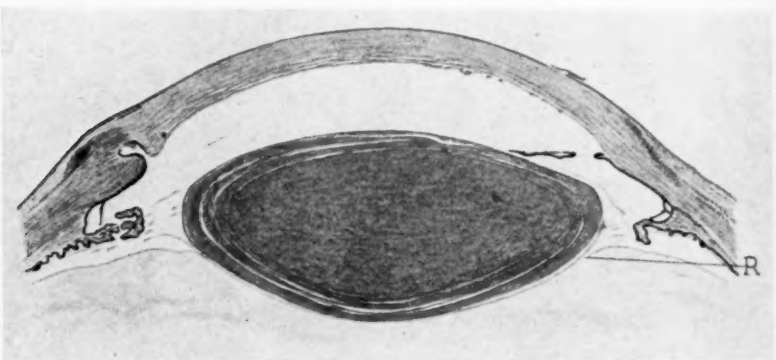

Fig. 5.—To the left are shown traces of the scar from an operation, partially permeated with blood. The cavity is lined with iris pigment. A thin, pigmented layer, all that remains of the iris, lines the internal sulcus of the sclera. A few red blood cells lie against the flat part of the ciliary body, and a few are seen in the recessus hyaloideocapsularis (*R*), which opens in the normal direction laterally. Practically no change can be recognized in the lens in spite of a clinical history of opacity and discoloration.

antagonistic to increase of tension, and a totally disintegrated lens would seemingly lead to shrinkage.

Vacuolation of Lens Fibers.—A system of vacuoles was a frequent observation in the subcapsular substance of the lens in these glaucomatous eyes, originating in a disintegration of the lamellas (fig. 4). The starting point of a system was near the pupillary margin of the iris, extending from here equatorially to the point where the capsular epithelium turns inward to form the germinal whorl. At the start the vacuoles were small, but before they disappeared they became larger and more conspicuous. When the system of vacuoles was narrow it usually split

the germinal zone into two parts, an inner and an outer; but when it was broad it entirely replaced the inner layers of the germinal zone, leaving a narrow strip of nuclei to the outside. These vacuoles were generally more superficial than those seen in senile cataract.

Fragmentation of Lens Fibers.—Bearing a special relation to the system of vacuoles, but different from them, was a peculiar form of fragmentation of the fibers, seen in the subcortical layer, to the inner side of the germinal cells, in 2 cases (figs. 8 and 10). This layer has normally a homogeneous appearance, but in these 2 instances the fibers were fragmented into small oblong units, sharply separated from one another. A fiber was never involved in its entire length. In a histologic sense, the fragmentation was similar to that seen in degenerating nerve fiber sheaths of the optic nerve with the Weigert method of staining. This similarity led to the conclusion that this picture was not an artefact but

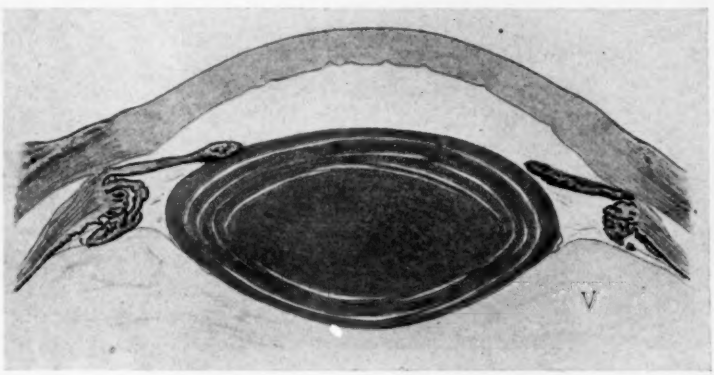

Fig. 6.—The eye of a man aged 42 was enucleated because of absolute glaucoma. The anterior chamber is shallow, and the filtration angle is obliterated. The iris is partially necrotic and contains numerous pigmented cells which have migrated into it. To the left the swollen pupillary margin of the iris is adherent to the lens and the underlying pigment layer is dissolved. The ciliary body is somewhat swollen, and the processes touch the root of the iris on both sides and press it against the cornea. The vitreous (*V*) is homogeneous. Its anterior limiting layer bulges forward into the circumlental space much farther than normal, especially on the left side, where it touches the ciliary processes over a broad area.

represented a stage in the formation of senile cataract. In all probability, increase in tension had little to do with it; otherwise, it would have been encountered before in the many lenses examined.

Discrepancy Between Clinical and Pathologic Changes.—One case of primary glaucoma was especially important in that clinically so much was seen, yet histologically so little. A yellowish white cataract was visible through a wide coloboma in the iris. Microscopic study showed only a scattering of cells in the posterior cortical layers (fig. 5), which

certainly could not have given the appearance of a "yellowish white cataract." Probably imbibition of fluid caused a change in the refractive index of the lens fibers without actually altering them. Unfortunately, such edema cannot be demonstrated in stained preparations. In life, edema in the cornea may occur after injury, causing it to take on a whitish hue, which disappears in time—proof that no essential damage was done to the lamellas. Similarly, the lens in diabetes may become whitish and swollen and with insulin treatment return to normal.

Occasionally a patient with a mature cataract is able to count fingers at several feet. Better known is the fact that in a case of glaucoma

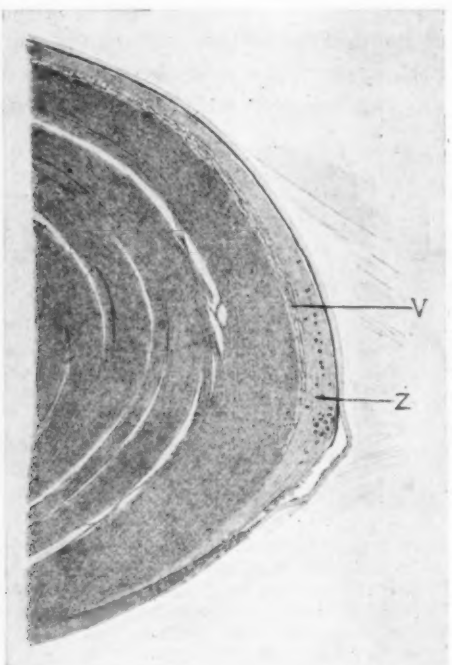

Fig. 7.—Detail of figure 2. At one place the capsule is separated from the germinal zone by an artefact, due to traction by the zonular fibers. The germinal zone (*Z*) is but little changed. Bordering its inner surface a row of small vacuoles (*V*) extends forward, gradually approaching the surface until it becomes subcapsular. The vacuolation is different from the fragmentation shown in figure 8.

with a totally excavated nerve head the patient may have good central vision, although the field is restricted. Interesting from this standpoint was the case of a woman aged 48 with absolute glaucoma of twelve months' duration. In spite of an almost total cataract and a deeply excavated nerve head, filled out with organized blood clot, the patient could discern hand movements at 2 feet (30 cm.).

Size of the Lens.—Although most of the lenses were in a swollen state, they were seldom much enlarged. However, the measurements of a lens in a slide are uncertain, first, because the fixation may cause it to shrink or swell according to the fixation used, and, second, because one is seldom sure that the section has been taken from the true meridian, and not from the slanting surface.

The Circumlental Space.—The measurements of the circumlental space, like those of the lens, were unsatisfactory because the width of the space is influenced by the way the section is cut and by the fixation fluid used. For instance, an eccentric cut through the lens produces an

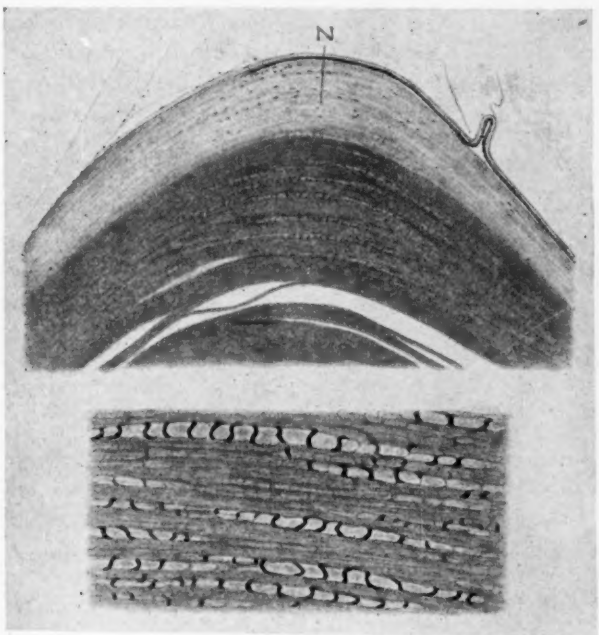

Fig. 8.—The eye of a man aged 76 which had had absolute glaucoma for four years and six months before enucleation. The germinal zone ($\bar{Z}$) is normal. To its inner side, in the subcortical region, files of fragmented zonular fibers are seen. They are not in the form of droplets, but are cylindric bodies, separated from one another by irregular oblique lines.

oblique section through the circumlental space and causes the latter to appear broader. Slight artificial detachment, due to shrinkage, may cause the processes to approach the lens. There was only 1 case in which the ciliary processes came into actual contact with the equator of the lens, and in this case they were extremely swollen.

Position of the Lens.—There was 1 example of the effect of a swollen and hardened vitreous on the lens after the glaucomatous globe had been opened (figs. 2 and 3). The patient was 47 years old. Three months

before the enucleation an iridectomy was performed to relieve the tension. The wound was ectatic, and the lens was pressed forward, completely occupying the corneal cavity and molded to its contour. The ciliary body was compressed by the vitreous, which bulged far forward into the circumlental space. As a complication following a filtering operation, this eye was thrown into a condition known as malignant glaucoma. By this term some surgeons designate cases in which, after an operation, a glaucomatous eye (glaucoma simplex) which has never shown inflammatory symptoms becomes harder than it was before and is inflamed. It makes little difference whether the operation is an iridectomy, a Lagrange operation (sclerectomy with scissors) or an Elliot sclerectomy with trephining. The anterior chamber remains abolished, and the wound may gape. There is severe pain, which is worse at night. The most disagreeable feature is that it is impossible to restore the anterior chamber or to lower the tension or relieve the inflammation. One can-

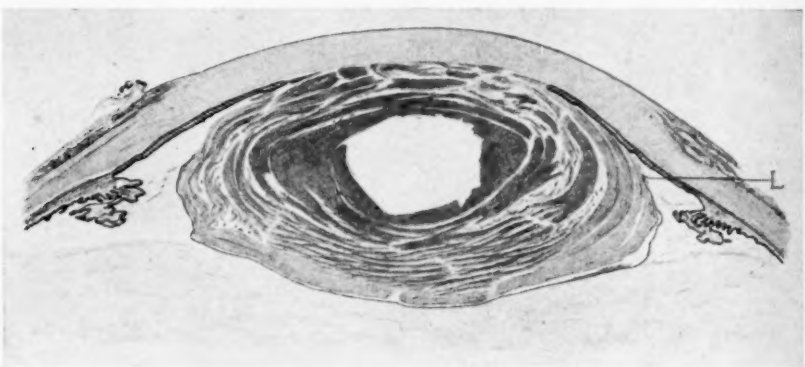

Fig. 9.—An eye with absolute glaucoma. The lens is disorganized and pressed against the cornea, which is bare of endothelium. The capsule of the lens (*L*) ends a short distance in front of the equator. Anteriorly there is not a trace of the capsule. The ciliary body on both sides is atrophic.

not foretell the tendency of glaucoma simplex to develop into postoperative glaucoma malignum. If this happens to one eye, an operation on the other eye is likely to be followed by the same complication, indicating that there is a constitutional inclination.

It is generally thought that malignant glaucoma, particularly since the lens is sometimes tilted into the wound, is always caused by a subchoroidal hemorrhage. In this series there were 2 cases of postoperative malignant glaucoma which were evidently caused by nonexpulsive subchoroidal hemorrhage. On the other hand, there were 2 cases in which the choroid was not detached. Here the cause of the malignant postoperative attack was certainly pressure from a swollen and hardened vitreous body. A theory as to the cause of primary glaucoma is that

first the pupil dilates and then the ciliary body becomes hyperemic from disturbance in circulation. This theory fails to explain the anatomic observations in the cases included in this paper, in which the ciliary processes were compressed against themselves or were pushed far forward. Hyperemia alone could not have displaced these processes. This was certainly the mechanical result of an expanded and hardened vitreous.

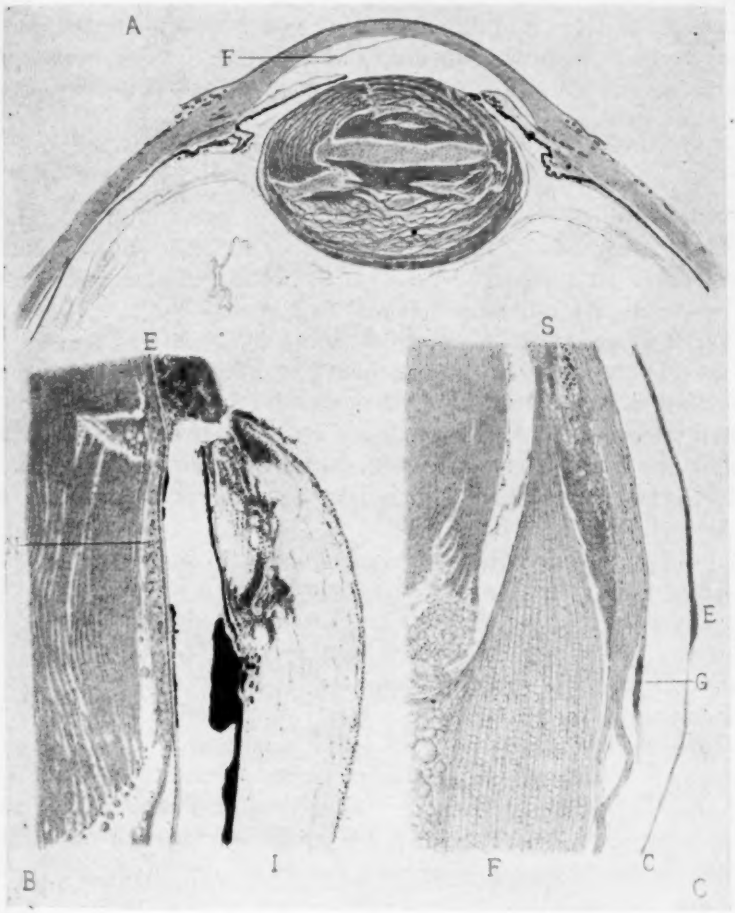

Fig. 10.—An eye with absolute glaucoma.

(*A*) The fine filament detached from the cornea represents a coating of red blood corpuscles. The iris is necrotic (*B*). The lens is broken up and swollen.

(*B*) The iris (*I*) is shadowlike, containing but a few nuclei. A row of red blood cells outlines the anterior limiting layer. The sphincter muscle is gone, and in its place are a few empty endothelial tubes. The desquamated pigment layer is gathered into a large black mass. The capsular epithelium (*E*) is normal. Beneath it, at (*N*), loose nuclei derived from desquamated cells lie in decayed lens matter. In the lens substance are many slits, debris and globules.

(*C*) At the equator (*E*) the lens capsule is detached. The thickened endothelium is an artefact. The germinal zone is partially preserved. Posteriorly, at (*G*), there is a group of pathologically proliferated germinal cells, which resembles a giant cell. The lens substance (*S*) is broken up. At (*F*) a broad zone of fragmented lens fibers stands out conspicuously.

The effect of a swollen vitreous on the recessus hyaloideocapsularis was interesting (figs. 6 and 7). Normally, the triangular space external to the hyaloid ligament faces laterally, but here it faces anteriorly because of the great bulge of the anterior limiting layer of the vitreous. Also, normally the limiting layer presses so lightly on the zonular system as to protrude but slightly between the different fibers. Figures 2 and 3 show the anterior limiting layer so strongly compressed between the fibers over the flat part of the ciliary body as to be sharply fluted, causing the fibers to be embedded in deep furrows. Such an arrangement is possible only when the vitreous, because of increased volume, causes strong pressure in all directions.

GENERAL COMMENT

As opacities in the lens of a glaucomatous eye are almost sure to increase, their presence forms a deciding factor in the type of operation to be selected for reducing the tension. Clinical and pathologic experience prompts me to warn against two operations. An extensive cyclodialysis frequently favors the more rapid development of the cataract and not rarely leads to insidious iritis, which is hard to counteract because atropine must be used cautiously. As to trephining, after such an operation the ciliary processes are often fixed to the scar and when, in the extraction of a cataract, they are cut through an extensive hemorrhage is apt to ensue, followed by a membranous formation, and possibly by sympathetic ophthalmia.

To differentiate between failing vision due to progressive cataract and failing vision due to progressive glaucoma, it is imperative that the tension be recorded and the fields be plotted from the very start of the treatment. If an eye has already been operated on for the relief of glaucoma, and it is considered desirable further to reduce the tension by extracting the cataractous lens, it is well to remember that a glaucomatous eye, once operated on, will stand a tension of about 30 mm., taken with a Schiøtz tonometer, better than an eye with the same tension which has not been operated on. Finally, a glaucomatous eye after operation is not very subject to an acute attack, whereas an eye not operated on stands always under the menance of such an attack.

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TREATMENT OF SUBCHOROIDAL HEMORRHAGE BY POSTERIOR SCLEROTOMY

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IN 1915 Verhoeff [1] reported saving an eye in which an expulsive subchoroidal hemorrhage had developed after a filtering operation for chronic noninflammatory glaucoma. This was the first report of successful retention and maintenance of function of an eye after expulsive hemorrhage, and it is to Verhoeff that credit is due for a method of dealing with this disaster.

It was not until 1938 that Vail [2] reported the second and third cases of successful management of expulsive subchoroidal hemorrhage. He employed Verhoeff's method of sclerotomy as soon as possible after the diagnosis was made. In his first case reported the hemorrhage occurred after intracapsular extraction of cataract; in the second, after a Graefe knife section preliminary to iridectomy for chronic noninflammatory glaucoma.

Since Vail's report, there has been no further recorded instance of an eye with useful vision being saved after this type of postoperative complication. Samuels,[3] in reporting on 8 eyes studied microscopically, advocated Verhoeff's method of attack on the problem. Expulsive subchoroidal hemorrhage is greatly feared, and in general when it happens the ophthalmologist bandages the eye for several days and then enucleates.

The following case is summarized in some detail in order to stress our experience while dealing with a supposedly destroyed eye.

From the Department of Ophthalmology, University of Wisconsin Medical School.

1. Verhoeff, F. H.: Scleral Puncture for Expulsive Subchoroidal Hemorrhage Following Sclerostomy: Scleral Puncture for Post-Operative Separation of the Choroid, Ophth. Rec. **24**:55 (Feb.) 1915.

2. Vail, D.: Posterior Sclerotomy as a Form of Treatment in Subchoroidal Expulsive Hemorrhage, Am. J. Ophth. **21**:246 (March) 1938.

3. Samuels, B.: Post-Operative Non-Expulsive Subchoroidal Hemorrhage, Arch. Ophth. **6**:840 (Dec.) 1931.

REPORT OF A CASE

A white man aged 54 entered the Wisconsin General Hospital complaining of progressive loss of vision during the past ten years. Thirteen years previously he was struck in the left eye with a chip of wood, after which objects seen with this eye appeared double and triple. Examination of his eyes revealed cataracts of the sclerosed type; in addition, the left eye had a dense gray anterior subcapsular plaque, 3 mm. in diameter. The fundi could not be seen well enough for description. Intraocular tension was 15 mm. in the right eye and 19 mm. (Schiøtz) in the left eye. On May 5, 1944 a combined intracapsular cataract extraction was done on the right eye. On the seventh postoperative day a small hyphema was noted, and three days later the diagnosis of choroidal detachment was made. Subsequently, the eye healed well, and vision of 20/20 with correction was obtained. Examination of the fundus revealed a linear patch of healed choroidoretinitis along the superior nasal vessels.

On Sept. 29, 1944 a combined extracapsular cataract extraction was done on the left eye. The eye was opened by making a section at the limbus with the keratome, enlarging it with scissors. Liquid vitreous was observed escaping from the wound, its loss producing a soft globe even before iridectomy. Attempted intracapsular delivery of the lens was made difficult by the softness of the globe, and capsulotomy resulted. The lens was then delivered with a loop to prevent its sinking into the vitreous cavity.

During the tying of the corneoscleral and conjunctival sutures the patient began to complain of acute pain in the eye. Nausea developed, and his skin became cold and clammy. It was noted, too, that the globe had become very hard and the wound began to gape. The interior of the eye appeared entirely black. The symptoms and signs pointed unquestionably to subchoroidal hemorrhage, and light projection tests then revealed response far in the temporal field only. A Graefe cataract knife was thrust through the globe in the inferior temporal quadrant 12 mm. from the limbus, immediately releasing a large amount of bright blood. Holding the knife twisted in the scleral wound resulted in evacuation of a diminishing stream of blood, though on removal of the blade the eye soon became very painful and stony hard and the conjunctival sutures taut.

The process of reinserting the knife into the scleral wound and releasing the blood was repeated at least six times, at the end of which the bleeding appeared to be stopped. It was estimated that at least 30 cc. of blood was drained from the eye during a half-hour period. Atropine was instilled and a gentle pressure bandage applied.

Postoperative healing of the eye was surprisingly good. The globe was moderately injected, and the anterior chamber contained considerable soft lens matter but no blood. Sanguineous drainage was slight. On the sixth postoperative day light perception had returned in the nasal field. On the nineteenth postoperative day details of the fundus could be seen well enough to determine that the choroid and retina were in normal position. The patient left the hospital on October 27.

Observation made on March 24, 1945 revealed that the left eye was quiet, with deep anterior chamber and a thin secondary cataract, through which details of the fundus were easily seen. There was a wide patch of healed choroidoretinitis along the superior temporal vessels similar to that seen in the right fundus. Macular pigment was clumped and granular. The right visual field was normal; the left had fair vision for form but no color vision. Intraocular tension was 15 mm. in the right eye and 15 mm. (Schiøtz) in the left eye.

Visual acuity was 20/15 in the right eye with a correction of 9.25 D. sph. ⊃ + 2.00 D. cyl., axis 20 and 20/100 in the left eye with a correction of 6.00 D. sph. ⊃ + 6.00 D. cyl., axis 180.

The cause of the bilateral choroidoretinal scars is obscure. As a rule choroidal detachment heals without producing marked disturbance in the fundus picture. The scars in the left fundus could have been produced either by the initial injury thirteen years earlier, which undoubtedly caused lasting complications, or by the operative complications.

COMMENT

Diagnosis of the expulsive type of subchoroidal hemorrhage is not difficult. The sudden severe pain; and the pallor, clammy perspiration and nausea associated with a rapidly hardening eyeball are unmistakable signs. It should be emphasized that the patient repeatedly complains of his discomfort during the rapid rise of intraocular tension. By quickly determining the light projection, the surgeon is aided in choosing the site for sclerotomy. Samuels [3] pointed out that the largest mass of blood is most often found on the temporal side, and anteriorly rather than far posteriorly.

Prophylactic measures, as advocated by Ziegler [4] and Samuels [3] and reviewed by Vail,[2] should not be overlooked, but the problem of anticipating subchoroidal hemorrhage is anything but easy. It is not to be denied, however, that surgical subchoroidal hemorrhage is a distinct threat in the fellow eye after it has occurred in the first eye.

Regan [5] reported the successful use of venesection following a "less violent" choroidal hemorrhage, but stated that the expulsive type "offers little or no opportunity for therapy of any kind."

The severity of the choroidal hemorrhage in the present case may perhaps be contested, since the ocular contents were not prolapsed; yet the course of events and the immediate evacuation of large quantities of blood on opening the sclera are proof of the type of complication. Only the lack of time and a tightly sewed wound prevented completion of the expulsive process.

It is our conviction that sclerotomy should be tried in instances of expulsive choroidal hemorrhage and the results reported, so that ophthalmologists may be better equipped to deal with this usually disastrous event.

Department of Ophthalmology, University of Wisconsin Medical School (6).

4. Ziegler: The Problem of Choroidal Hemorrhage in Cataract Extraction, in Contributions to Ophthalmic Science, Menasha, Wis., George Banta Publishing Company, 1926, p. 7.

5. Regan, J. J.: Venesection in a Case of Choroidal Hemorrhage Following Cataract Extraction, Am. J. Ophth. **26**:534 (May) 1943.

LABILITY TEST FOR CHRONIC SIMPLE GLAUCOMA

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THE IMPORTANCE of chronic simple glaucoma as a cause of ocular disability and blindness is unquestioned. It is fortunate that newer pharmacologic developments and widening surgical experience have provided therapeutic measures that in many cases prove effective in controlling the insidious progress of this disease.

However, before effective therapy can be employed, the diagnosis of chronic simple glaucoma must be made with some degree of assurance. This is so because the proper treatment of the disease involves either surgical intervention or an indefinite period of medication, or both, and lifelong ophthalmologic surveillance. Such a regime, obviously, is not one to which the patient can be subjected lightly. However, the constant threat of danger from the disease if present requires the institution of treatment at the earliest possible time, and a prolonged period of diagnostic observation without therapy cannot be condoned. It is obvious, therefore, that a quick and certain method for the diagnosis of chronic simple glaucoma is greatly to be desired.

Such a diagnosis is established without difficulty when in a quiet eye the intraocular pressure is found to be above the normal range or advanced signs of glaucoma are present, such as prominent excavation of the nerve head or typical changes in the visual field. In eyes presenting such signs the course of the disease has usually advanced sufficiently to reveal its presence by the irreversible damage it inevitably produces if uncontrolled. There are, however, patients who consult the ophthalmologist because of ocular symptoms that suggest the presence of chronic simple glaucoma, but who have normal ocular tensions even on repeated office examinations. Such patients may show either no functional or anatomic signs of glaucoma or insufficient evidence for the diagnosis of the disease. The diagnostic challenge such patients present is important, since the absence of definite evidence of chronic simple glaucoma does not eliminate the possibility of that disease being present in a mild or an early stage. At such a time the need of proper diagnosis and treatment of the condition is urgent to prevent the insidious occur-

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rence of more advanced ocular damage. Because of the frequent difficulty in diagnosing early chronic simple glaucoma, several ingenious diagnostic procedures have been devised. Those which attempt to demonstrate the presence of the disease by causing an abnormal elevation in ocular tension are often referred to as provocative tests.

Fundamentally, the purpose of such tests is to throw a strain on the mechanism whereby normal ocular tension is maintained within a physiologic range. A consideration of the many unrelated factors which must be integrated to produce a homeostatic level of intraocular pressure has led many observers to conclude that such control must exist. While its exact nature is still uncertain, it seems likely that some disturbance in such a regulatory system is present in chronic simple glaucoma. The presence of such a pathologic disturbance may be demonstrated by any method whereby a sudden strain is thrown on the mechanism of control of tension. In such circumstances, a faulty regulation of ocular tension manifests itself in an abnormal rise of intraocular pressure. In non-glaucomatous eyes the normally effective control of tension is demonstrated by a less labile variation in pressure.

The older provocative tests now commonly employed for the diagnosis of chronic simple glaucoma, such as the dark room test, the caffeine and water-drinking tests and the use of mydriatics, have proved of limited value because the elevations in ocular tension that they produce when the result is "positive" are often not distinctly abnormal, and their "negative" results are frequently unreliable. In other words, the strain they place on the regulatory mechanism of ocular tension is often too small, or too inconsistent in effect, to be of diagnostic value. The need for a more reliable provocative test than the methods usually employed is thus apparent.

About a year ago, Dr. Robert K. Lambert and I [1] devised a method whereby the effectiveness of the control of tension in any eye could be quantitatively indicated and defective regulation indicative of chronic simple glaucoma be readily demonstrated. Our method was based on the following reasoning:

The enveloping structures of the globe are reasonably inelastic, and the formed elements within the eye have a relatively constant volume. The most important factors in determining the intraocular pressure at any time, therefore, are the variations in volume of the intraocular fluids. The amount of fluid within the eye depends primarily on the intraocular blood flow. It therefore seemed probable to us that the induction of a transient vascular congestion in the eye would tend to produce a significant elevation in tension that would be most pronounced if the normal controlling mechanisms were pathologically defective.

1. Bloomfield, S., and Lambert, R. K.: The Lability of Ocular Tension, Arch. Ophth. **34**:83 (Aug.) 1945.

After prolonged study, we devised a procedure whereby such transient intraocular hyperemia could be safely produced. Appreciable increases in ocular tension resulted, which were significantly greater in eyes with chronic simple glaucoma. We called our method the lability test because its purpose is to measure quantitatively the lability of tension in any eye and, accordingly, to demonstrate the presence of a defective regulation of pressure associated with chronic simple glaucoma by causing transiently an abnormal rise in intraocular pressure.

Basically, the lability test consists in the simultaneous application of the cold pressor test of Hines and Brown [2] and the jugular compression test described by Schoenberg.[3] The principle of the cold pressor test is that elevations in systemic blood pressure are produced by sudden applications of cold to the body. Our studies [1] showed that in such circumstances a transient increase in ocular tension occurred simultaneously, suggesting an increased flow of blood into the eye. Furthermore, these increases in ocular tension were not proportional to the increase in systemic blood pressure with which they were associated. Compression of the jugular veins by pressure on the neck interfered with the outflow of blood from the eye. Our published study [1] has shown that neither of these procedures alone produces sufficiently consistent or appreciable effects on intraocular pressure to be of diagnostic value. However, the combination of the two has provided a diagnostic test of great effectiveness in our experience, and one that is applicable to all eyes regardless of the width of the angle of the anterior chamber. However, it must be emphasized that the diagnostic value of the lability test has been studied only in cases of chronic simple glaucoma. There is evidence to indicate that in cases of acute congestive glaucoma the test when applied during the interval between attacks may demonstrate a normal lability of intraocular pressure.

THE LABILITY TEST

The lability test is performed by first measuring the tension of each eye to be studied. The patient then places one open hand up to the wrist in ice water. Simultaneously, a blood pressure cuff previously placed loosely about the neck is inflated to a pressure of 50 to 60 mm. of mercury, as indicated on the attached manometer. At the end of exactly one minute, the ocular tension is again recorded, with the hand still in ice water and the cervical pressure undiminished. Then the hand is withdrawn; the pressure cuff is removed, and the test is over unless a repetition is desired for purposes of accuracy.

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2. Hines, E. A., Jr., and Brown, G. E.: Standard Test for Measuring Variability of Blood Pressure: Its Significance as Index of Prehypertensive State, Ann. Int. Med. **7**:209 (Aug.) 1933; Cold Pressor Test for Measuring Reactibility of Blood Pressure: Data Concerning Five Hundred and Seventy-One Normal and Hypertensive Subjects, Am. Heart J. **11**:1 (Jan.) 1936.

3. Schoenberg, M. J.: Artificial Induction of Ocular Hypertension by Compression of the Jugular Veins: Its Physiologic Aspect, Arch. Ophth. **1**:681 (June) 1929.

Our studies have shown that the response of any eye to the lability test is almost always qualitatively consistent in repeated performances of the test, although numerically the increase in tension in any eye often varies with repetitions of the test. In other words, if the original result is abnormal, subsequent performances of the test will also tend to give abnormal responses, though the actual increases in tension may vary. The tension in all cases returns to its original level within two or three minutes. Figure 1 shows the setup for the actual performance of the test, except that the hand should be immersed in the ice water up to the wrist, rather than incompletely, as shown.

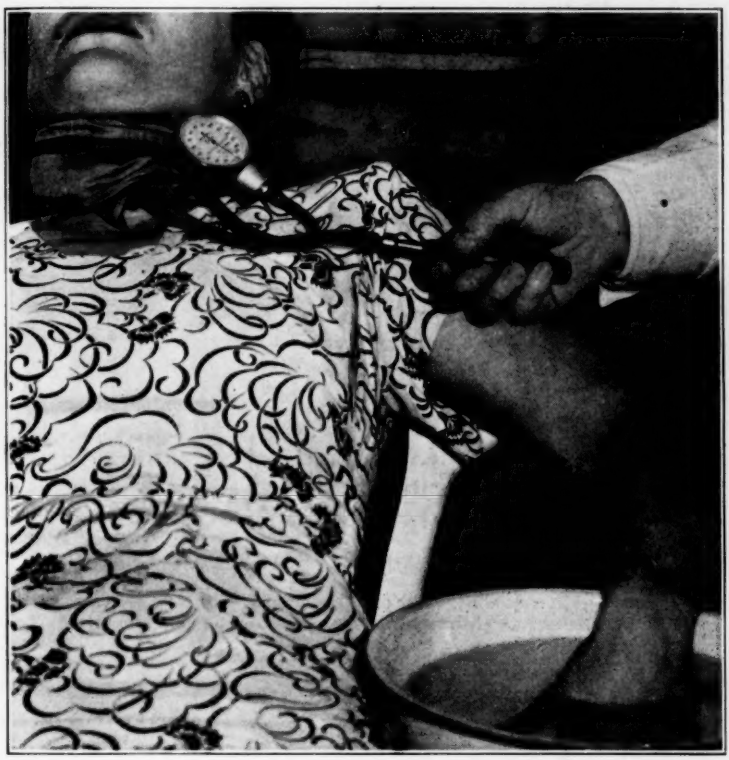

Fig. 1.—Preparation of the patient for the performance of the lability test.

At the Mount Sinai Hospital this procedure has been performed on over 300 patients, without any serious complaint or undue discomfort. Old patients and patients with hypertension have been subjected to it without a single complication. The actual test requires only a minute; it is easily performed in the office or in the hospital room, and only a few technical points must be remembered. One is that the water must be ice cold, and for that purpose chipped ice or ice cubes are usually placed in the water for about fifteen minutes before use. It is also necessary that the bladder in the pressure cuff be applied anteriorly on the neck, so that both jugular veins are compressed simultaneously, without protection from surrounding structures. Furthermore, the pressure must be maintained at just below 60 mm. of mercury until after the tension is recorded, which should be at the end of exactly

one minute. The patient can breathe easily with such pressure about the neck, and, of course, at such levels arterial circulation is unimpeded. Although some reddening of the face occurs, no real discomfort is present. Finally, for purposes of diagnosis, the test is performed only on eyes not under the influence of miotics.

OBSERVATIONS

In our original paper,[1] we showed that if in any eye this procedure produced a rise in ocular tension of more than 9 mm. of mercury (Schiøtz) the diagnosis of chronic simple glaucoma was strongly suggested. Moreover, if the height, or ceiling, to which the ocular tension rose in the tested eye exceeded the normal limit of 30 mm. of mercury (Schiøtz), whether or not the actual rise in tension was more than 9 mm. of mercury, such a diagnosis was even more conclusively indicated.

Figure 2 illustrates the responses to the lability test of 77 eyes without any history or signs of chronic simple glaucoma. The average age for

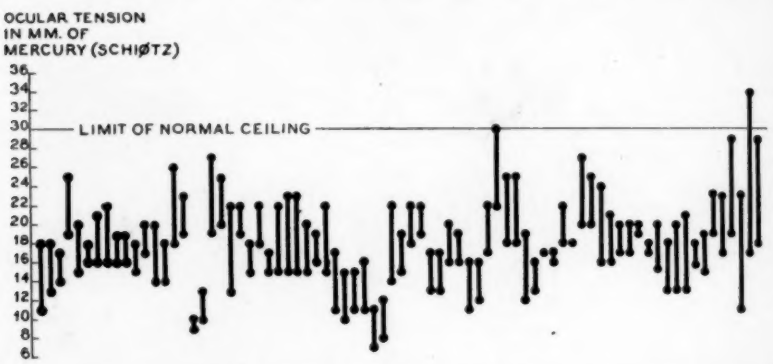

Fig. 2.—Response to the lability test of eyes without a history or signs of chronic simple glaucoma. Each vertical line shows the response of a single eye in this series. The bottom of each of these lines indicates the level of tension when the test was begun, and the top of each line, the height or ceiling to which the tension rose. The length of each vertical line, therefore, demonstrates the actual rise that occurred in each eye.

the patients in this group was 48, and all but 8 of the subjects were more than 35 years old. Thus, the age level of these patients was comparable to that of the group with chronic simple glaucoma. Many of the eyes in this nonglaucomatous category had varying degrees of cataract formation; some presented postoperative aphakia, and the majority had no apparent abnormality. There was no consistent difference in response of any of these types of nonglaucomatous eyes.

As figure 2 graphically shows, in only 4 of these 77 nonglaucomatous eyes did the rise in tension that occurred in response to the lability test exceed 9 mm. of mercury. The vertical lines for these 4 eyes appear at the right of the chart. Even more significantly, in only 1 eye, that in which the greatest increase in tension occurred, was the level raised to

over 30 mm. of mercury (Schiøtz), indicating a definitely abnormal result. In 1 other eye the tension rose to exactly 30 mm. of mercury (Schiøtz), a result which would be interpreted as suggestive, but not definitely indicative, of the presence of chronic simple glaucoma.

In figure 3 are shown the results of the lability test when applied to 29 untreated eyes with known chronic simple glaucoma, which were tested when the tension without use of drops was within normal range, that is, below 30 mm. of mercury (Schiøtz). Thus, the results for these 29 eyes simulated the results for eyes in which the presence of glaucoma is suspected but uncertain because the tension is normal. This is the circumstance for which these diagnostic tests are specifically designed. As shown, the lability test raised the level of tension in each

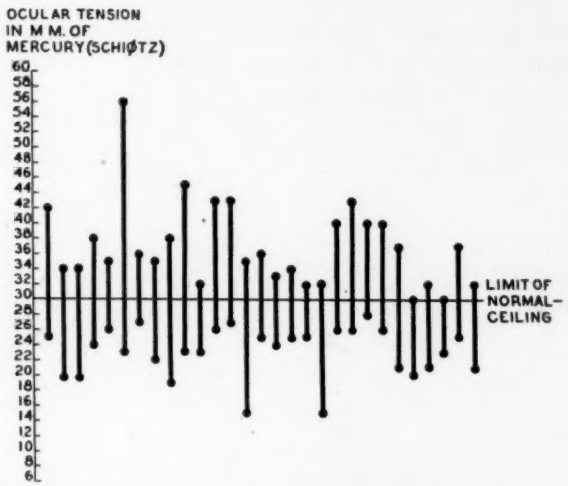

Fig. 3.—Response to the lability test of untreated eyes with chronic simple glaucoma but with ocular tensions normal at the time of the test. Each vertical line shows the response of a single eye in this series, as in figure 2.

of these glaucomatous eyes transiently to the level of 30 mm. of mercury or more (Schiøtz). In the 2 instances in which the tension rose to exactly 30 mm. of mercury (Schiøtz) the result would be considered suggestive of the presence of chronic simple glaucoma. In the remaining 27 eyes in this glaucomatous series, the tension rose above the normal ceiling of 30 mm. of mercury (Schiøtz), indicating more definitely the presence of that disease. It should be recalled that in figure 2 it was shown that such an abnormal result occurred in only 1 of 77 comparable nonglaucomatous eyes.

These studies on the lability test have been concerned exclusively with its possibilities in the diagnosis of chronic simple glaucoma. In a small number of cases, the test was applied to eyes subject only to recur-

ring attacks of acute congestive glaucoma. The results for these eyes gave some indication that the reaction of such eyes during quiescent periods is normal, and so differs from that of eyes with chronic simple glaucoma. However, further experience will be required to establish such a distinction, if valid. Similarly the response to this procedure in eyes with secondary glaucoma awaits clarification. At present the lability test is used to establish the diagnosis only of chronic simple glaucoma.

SUMMARY AND CONCLUSION

There is a need of a more reliable test to reveal the presence of early chronic simple glaucoma.

The lability test is a simple and quick procedure devised for that purpose.

A study of its results when applied to a series of eyes with chronic simple glaucoma and to another group without that condition indicates that it is a highly reliable test for that disease.

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MODIFIED SNELLEN SUTURE FOR PROLAPSED CHEMOSED CONJUNCTIVA

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AND
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WHILE ectropion is a common condition with a large number of corrective surgical procedures, an extreme degree of ectropion resulting in prolapse and chemosis of the conjunctiva is rare and constitutes a perplexing problem for the ophthalmic surgeon. The following report of a case presents a technic, hitherto undescribed, for treating the chemosed, everted, exposed conjunctiva of the lower lid.

REPORT OF A CASE

History.—J. R., 49 year old white man, fell off a tugboat on Feb. 2, 1945, was unconscious for eighteen hours, and was treated at another hospital. He had sustained occipital and parietal fractures of the skull, intracranial arteriovenous aneurysm, bilateral exophthalmos, fourteen fractured ribs and a fractured right scapula. On May 30, 1945, the right internal carotid artery was occluded by application of a Michel clip for the arteriovenous aneurysm. The intracranial bruit disappeared. Forty-eight hours later, the patient developed eversion and prolapse of the conjunctiva of both lower eyelids. He was discharged at this time because it was felt that further treatment would be of no value. Vision uncorrected was reported as 20/70 in both eyes.

On admission to this hospital, vision of the right eye was 20/25, not correctible; of the left eye, 20/20. Tension was normal. There was bilateral exophthalmos, more marked on the right. The left pupil was somewhat larger than the right, but both reacted to light. There were pronounced hypertrophy and chemosis of the conjunctiva of each lower fornix. The conjunctival vessels were congested, more so on the right. The right fundus revealed a congested disk with full tortuous veins, scattered hemorrhages and some edema in the surrounding retina. The left optic disk appeared to have temporal pallor. There was no audible bruit over the skull. Slight weakness of the right external rectus muscle was noted. Perimetric study showed minimal contraction of the right peripheral field. Roentgenograms of the orbits and skull revealed no evidence of fracture or of suggestive increased intracranial pressure.

Operative Procedure and Course.—The cornea and conjunctiva of both eyes were anesthetized with tetracaine hydrochloride, 0.5 per cent. Cotton pledgets

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From the Veterans Administration Hospital.

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saturated with equal parts tetracaine hydrochloride, 0.5 per cent, and 1:1,000 solution of epinephrine were applied to the prolapsed conjunctiva of both eyes for five minutes. This resulted in some reduction of the chemosis, and the conjunctiva could be inverted. However, this did not hold. Using a double-armed 3-0 black silk suture, a horizontal mattress suture was inserted into the conjunctiva at the junction of the inner and middle thirds 10 mm. from the lid margin. Each arm of the suture was then carried through the periosteum of the inferior orbital ridge and out through the skin of the cheek. A similar mattress suture was made at the junction of the middle and outer thirds. The sutures were then pulled down-

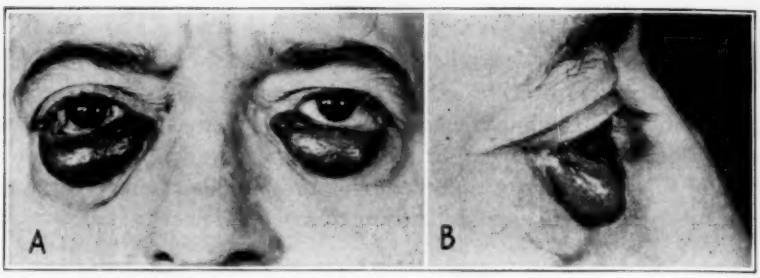

Fig. 1.—*A*, front view of eyes showing hypertrophied, prolapsed, chemosed conjunctiva of lower eyelids before operation; *B*, lateral view.

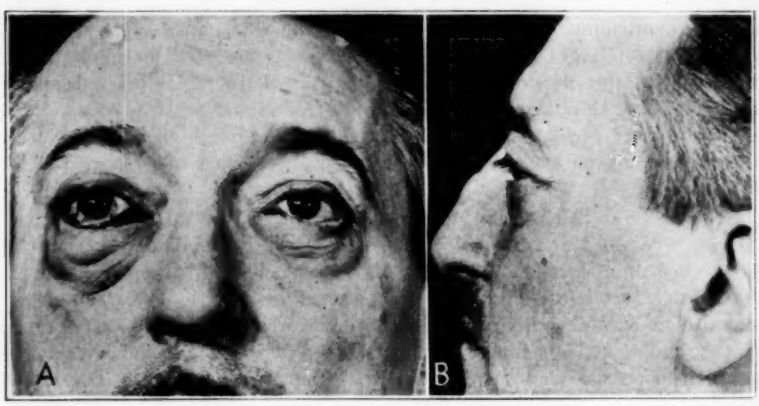

Fig. 2.—*A*, front view of eyes eighteen days after operation; *B*, lateral view.

ward, thus inverting the prolapsed conjunctiva and reforming the inferior cul-de-sac. The sutures were tied over a roll of absorbent cotton. The same procedure was used for both eyes. The eyes were well lubricated with boric acid ointment. Two traction sutures were inserted above the margin of each upper lid, and with these sutures the upper lid was drawn down over the lower lid and held in place with strips of adhesive tape. Eye pads were applied and secured with Scotch tape.

On the sixth postoperative day, there was indurated edema with tenderness of the right lower eyelid. The sutures were removed. Penicillin, 50,000 units, was injected intramuscularly, every three hours, eight times a day, for four days. The inflammation subsided completely. On the eleventh day, slight entropion of the

left lower eyelid was noticed. It was treated by applying a strip of adhesive tape vertically on the left lower eyelid and cheek so as to evert the lid enough to keep the cilia off the globe. This was continued for five weeks before the entropion was cured. The patient was discharged after ten weeks in the hospital; on reexamination, two months later, the condition was the same.

Comment.—The original Snellen[1] suture for ectropion uses two horizontal mattress sutures at the edge of the tarsus nearest the margin of the eyelid. One is placed at the junction of the outer and middle third; and the second, at the junction of the inner and middle third of the conjunctiva. Each arm of the two sutures is carried down through the eyelid behind the tarsus, and is brought through the skin 2 cm. below the margin of the lid and about 3 mm. apart. The sutures are tied over a gauze or cotton roll, and left in place from six days to three weeks. For this patient the procedure was modified because of the marked prolapse of the conjunctiva and the lack of an inferior cul-de-sac. It became necessary to modify this procedure to form an inferior fornix. According to Whitnall,[2] the distance from the margin of the lower lid to the inferior conjunctival fornix in the eyes in the closed position is 9 to 12 mm. The conjunctival sutures were therefore inserted 10 mm. from the margin of the lower eyelid to form the inferior conjunctival fornix this distance from the margin of the lid.

After the operation, there was still some redundancy of the conjunctiva nasally. Further surgery was discussed with the patient, but he refused because he was planning to return to France.

COMMENT

A new operative procedure, a modification of the Snellen suture for ectropion, was used successfully in the treatment of prolapsed chemosed conjunctiva of the lower eyelids.

This procedure has the twofold purpose of restoring the prolapsed conjunctiva and of reforming the inferior fornix.

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1. Snellen, H.: Cong. internat. d'opht., Paris, 1869.
2. Whitnall, S. E.: Anatomy of the Human Orbit and Accessory Organs of Vision, ed. 2, New York, Oxford University Press, 1932.

OFFICIAL COLOR SENSE CONTROL IN SWEDEN

C. G. BOSTRÖM, M.D.
AND
I. KUGELBERG, M.D.
STOCKHOLM, SWEDEN

DURING the last ten years official color sense control in Sweden has been well organized; about this we shall give a short account.

The control is divided into two stages: In the first stage any medical practitioner with a normal color sense may perform the examination. The second stage is of a more scientific nature, as the examination is made by ophthalmologists with special training and approved by the board of directors of the Medical Department. The latter stage is concerned with complicated or doubtful cases, and in this stage must also be established the quality and degree of the defect in the color sense.

Naturally all necessary methods will be used in the second stage examinations, i. e. not only different pseudoisochromatic plates, but also spectral apparatus (Nagel, Göthlin) as well as test lanterns (the Eldridge-Green color perception lantern and Kugelberg-Karpe's so-called contrast lantern), etc. Examinations in the first stage are made with pseudoisochromatic diagrams only.

In 1934 Sweden officially changed to the use of pseudoisochromatic plates, it having been found that Holmgren's so-called wool tests could not be relied on, either in the hands of a medical practitioner or in those of an expert. Sweden has resolutely adhered to the use of at least two different series of pseudoisochromatic diagrams, thus making possible a confirmation of the results of the examination.

In 1934 the use of Ishihara plates was prescribed officially. Those plates, up to and including the fourth edition, had been used unofficially for a long time, and were considered to be of excellent quality. In connection with the Ishihara plates a new Swedish series, edited by Göthlin and Boström, "Tabulae pseudo-isochromaticae G. B.," became compulsory. Because of the variations in the quality of the Stilling series and the growing deterioration of the plates, they were considered no longer fit to be used. Unfortunately the later editions of Ishihara's series showed considerable imperfections; the fifth was somewhat poorer, and the sixth was still worse. In 1936 the Medical Department consequently found it necessary to forbid the use of numbers 4, 5, 10, 11 and 16 of the latter edition. The defects in Ishihara's seventh edition

were so obvious that many persons with a normal color sense were able to read the diagrams which should have been discernible only by certain color-defective persons.

In 1936 it was obvious that Ishihara's series had undergone the same deterioration which long before (1915) had been observed in the Stilling series.

During the war importing of Ishihara's series was stopped; so in 1942 the Medical Department was obliged for the time being to permit the issue of color sense certificates based on examinations with Göthlin-Boström's pseudoisochromatic diagrams only. In 1944, however, we published a new Swedish series of color plates: "Tabulae pseudo-isochromaticae B. K." In the same year it was accepted for first stage examinations in connection with the pseudoisochromatic diagrams of Göthlin and Boström. Thus the old goal was once more attained, i. e. the simultaneous use of two different series pseudoisochromatic plates. A brief account of the new diagrams follows.

The series consists of twenty plates, seventeen of them for diagnostic purposes and three of them without numerals or figures. The latter three serve to disclose dissimulation. An instruction plate (as for instance Ishihara's first one) was not considered necessary. The plates are of the same size as Ishihara's and are also fixed on a so-called Leporello carton. The diagrams show round, colored spots, all of them with a diameter of 2.5 mm. In all diagrams except two, the mutual position of the spots is the same. For technical reasons it has been necessary to turn the background of those two 90 degrees. On 15 of the diagrams there is a figure and in 2 a serpentine line. The numerals or figures as well as the background are produced in three different degrees of luminosity toned to each other. It has been found that this renders the task more difficult for a color-defective person, while a normal one scarcely is distracted by it.

As to the color selection, simple confusion colors have been used only. Thus every diagram contains only two colors, each in three different degrees of luminosity.

The purpose of the new diagrams is to detect all types of color defects, except the tritanopsic and the tritanomalous. These are very rare and also have no practical importance as far as colored traffic signals are concerned. No less than fifteen different confusion colors have been composed in order to cover as many variations as possible of the anomalous trichromat. While yet in print the series was proof read by persons whose scientific type of color defect previously had been established by spectroscopic examinations. As will be seen from the foregoing, Ishihara's method of using figures only to be perceptible to color-defective persons has been discarded. However fascinating and pleasant to the routine examiner Ishihara's "pseudo-figures" may be, experience has

unfortunately shown that these figures often are unreliable, causing uncertainty in the exact estimation of the color sense. As a matter of fact, not only color-defective persons but also normal ones read the figures which should be perceptible only to patients with defective color vision. To a certain extent this is evidently due to the fact that these plates are too dependent on the content of short wave light as well as on the testee's state of adaptation. By the exclusion of the "pseudo-figures," the dependence on the quality of the light decreases. Naturally all diagrams have to be shown in daylight or in the light of a good daylight lamp.

The time of exposure for every plate must not exceed fifteen seconds. In most cases, however, a considerably shorter time is sufficient. It sometimes happens that a color-defective person at first perceives the figure for a moment, but that it vanishes on further observation. In case of obvious difficulty to make out a figure, the patient is allowed to try to point out the figure. In this manner a color defect is often revealed.

As to the estimation of the color sense, the inability to make out two diagrams means defective color vision. The inability to perceive one diagram means that the color sense must be looked on as doubtful. The patient must then be subjected to further examinations with spectral apparatus and other methods (i. e. the second stage) in order that a decisive conclusion may be drawn.

The diagrams are not made with a view to a diagnosis of the quality of the color defect. This is not possible with any degree of certainty with pseudoisochromatic diagrams only; on the other hand, an exact classification is in most cases without importance. Neither is it advisable to base an exact estimation of the character of a defect in color vision on the examination with pseudoisochromatic plates only. A complementary examination in the second stage also is necessary.

It is well known that simulation of color blindness is rare while attempts at dissimulation of defects of color vision are the more common. To make dissimulation more difficult, certain plates have been added. Furthermore, the pattern of most of the plates has been made in the same way. Moreover, the arrangement of the plates should be changed from time to time, the 6's and 9's should be inverted, etc.

The pseudoisochromatic plates of Boström and Kugelberg have been made in half tone print, which probably is a novelty. The plates have been exposed to ultraviolet rays, showing that they have fast colors. Finally, it may be mentioned that Kirurgiska Instrument Fabriks A. B.,-Kifa-Stockholm, has the copyright for the new series.

Clinical Notes

A RADICAL INNOVATION IN CONTACT LENSES

JOSEPH I. PASCAL, M.D.
NEW YORK

From the time of the earliest anatomic studies the eye has been described as practically a sphere, an idea which is reflected in the term eyeball. When the idea of making contact lenses to fit directly on the eye arose, it was but natural, therefore, that a globular shell was assumed to be the proper form. Blown contact lenses were designed to approximate a sphere. The first sets of ground glass contact lenses were all made as sections of a sphere, the different sizes being sections of spheres with different radii.

Many eyes were fitted comfortably with these spherical contact lenses, but a great many others could not be fitted satisfactorily. It was soon discovered that, minutely considered, the average eye was far from a regular symmetric sphere and that in most instances the spherical lens sat ill on a nonspherical eye. The next stage was to consider the eye, at least the anterior section of it, as part of a toric surface having two spherical curves at right angles to each other. Many eyes were found to conform to this shape, and contact lenses made on the toric principle satisfied many patients. But here, too, it was soon found that the majority of eyes did not fall into this toric pattern and that lenses fitted on the toric principle satisfied relatively few patients.

A significant step forward was made when Dr. Dallos developed the molding technic. On the face of it, it seemed that a lens made to a mold of the eye would provide the ideally fitting lens. Experience, however, has shown it to be otherwise. It may be added that Dr. Dallos in his early work felt that a mold taken of the eye in one position was not adequate. He took five molds of each eye: one mold of the eye in the primary position and then one with the eye turned in each of the four cardinal directions. He then made a composite mold from these five molds. However, lenses made from the composite mold or the single mold did not in general fulfil the expectations.

At best the mold is only an approximate replica of the living, natural eye. Lenses made from molds generally exert too much pressure on the eye and almost always have to be repeatedly modified, tightened, loosened, and so on, in an effort to make them comfortable. With all that there are a great many failures. Curiously, a contact lens which by repeated adjustments is made to have a "glove fit" on the eyeball is sometimes even more uncomfortable than was the original, more or less ill fitting or loosely fitting lens.

An experimental study as to what kind of curve would best fit the great majority of eyes brought to light the almost unexpected emergence of the cone. It was found that if the scleral section was part of a cone, and the angle of the cone was so chosen that it rested tangentially against

the eyeball a minimum of pressure was exerted. Instead of a large bearing surface between lens and sclera, it was found that sometimes a narrow tangential band 1 to 3 mm. wide set inside the edge of the lens gave more comfort than any other surface. To prevent the lids from hitting against the temporal margins of the lens, the temporal portion of the tangent cone lens is provided with a flange, a small section of a sphere which merely rests against the eyeball. The adherence of the lens onto the sclera is accomplished by the conic section of the scleral part of the lens, which also allows a small dynamic lag of the lens when the eye is turned in different directions.

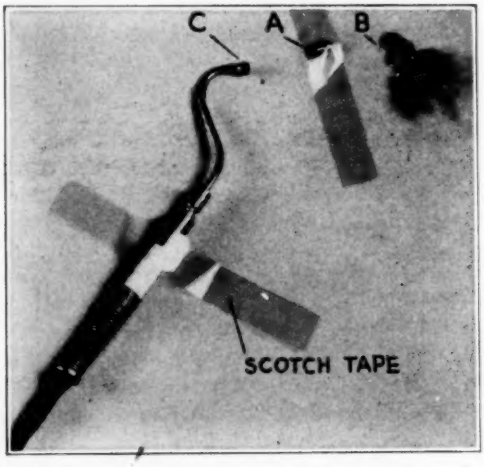
The problem of contact lenses has not yet been completely solved. For that matter, what problem in applied visual optics has been completely solved? But the introduction of the tangent cone lens marks a significant novelty in the practical fitting of contact lenses.

37 West Ninety-Seventh Street.

DANGEROUS EXPLOSION OF TRANSILLUMINATOR

LOREN GUY, M.D.
NEW YORK

A near disastrous accident occurred in my office not long ago which may interest and forewarn others. A patient consulted me regarding a detached retina. In the course of the examination transillumination of the globe was planned. The patient was put in the room



The Lancaster transilluminator showing, *A*, the tip that hit the wall at *B*, tearing off plaster and smudging the area, and *C*, the rest of the transilluminator. Scotch tape holds the parts in place for the illustration.

where this is done and the Lancaster transilluminator, which was connected to the central electric circuit, was turned on and immediately exploded. The tip of the instrument containing the bulb (*A* in the illustration) broke and hit the wall with great force, breaking the plaster and

smoking the area (*B*). If the tip had not been pointed in the direction of the wall, it might have hit the patient, my nurse or me. The patient's globe would undoubtedly have been badly ruptured, and possibly the tip of the transilluminator would have entered the paranasal sinuses or even the cranium.

The lesson to be learned in using such instruments is to point them in a direction in which they can cause the least damage if they explode. They should be treated with the same respect as a loaded gun.

40 East Sixty-Second Street.

News and Notes

EDITED BY DR. W. L. BENEDICT

GENERAL NEWS

Ophthalmic Laboratory Established by Estelle Doheny Eye Foundation.—The Estelle Doheny Eye Foundation announces the establishment of an ophthalmic laboratory at St. Vincent's Hospital, Los Angeles, designed to provide certain modern ophthalmic facilities badly needed in Southern California.

The immediate functions of the laboratory are: (1) to serve as a pathologic laboratory for the diagnosis and registration of pathologic specimens, with preparation of gross specimens and microscopic slides for ophthalmologists submitting specimens, and for the building up of a museum of pathology of the eye; (2) to serve as a bacteriologic laboratory in which diagnostic scrapings, smears and cultures can be studied, animal inoculations made and the sensitivity of organisms to various drugs and antibiotics determined; (3) to provide facilities for fundus, gross and slit lamp photography and to maintain a library of photographs and motion pictures for the teaching of ophthalmology; (4) to provide an eye bank for Southern California, with registry of potential donors and recipients (donor material will be collected, examined and distributed, and facilities may later be provided for limited instruction in corneal transplantation procedures); (5) to distribute and loan certain drugs and equipment that are not otherwise available in the community, and (6) to make available certain special equipment for radiation therapy of the eye for use outside the laboratory.

Dr. Alan Woods, professor of ophthalmology at Johns Hopkins University School of Medicine; Dr. Cecil O'Brien, professor of ophthalmology of State University of Iowa College of Medicine, and Dr. Phillips Thygeson, formerly professor of ophthalmology at Columbia University College of Physicians and Surgeons and now associate professor at the University of California Medical School, will serve on the advisory board. Dr. A. Ray Irvine, professor at the University of Southern California School of Medicine, will act as chairman of the original board. It is contemplated that the board will also include prominent business and professional leaders, as well as representatives from the ophthalmologic departments of local hospitals, medical schools and the ophthalmologic section of the Los Angeles County Medical Society.

Dr. Peter Soudakoff, formerly associate professor of ophthalmology at the Peking Union Medical College, will serve as full time pathologist at the laboratory. It is planned that, as part of the residency program of the eye service of the Los Angeles County Hospital and of certain local veterans hospitals, each resident will spend two or three months in the laboratory. It is anticipated that a research associate, granted a fellowship in basic ophthalmologic research by the Foundation, will be added to the laboratory staff from time to time.

In creating this perpetual charitable foundation dedicated to the conservation and restoration of eyesight, Mrs. Doheny, with great generosity and discerning wisdom, has been careful to insure a flexibility of organization to take care of the immediate practical needs and, at the same time, to provide for eventual development of much needed research in ophthalmology.

Request for Ophthalmic Literature and Texts for Library in Batavia.—Dr. J. C. van Manen, the newly appointed head of the Department of Ophthalmology at the Medical University, Batavia, Netherlands East Indies, requests ophthalmic literature for his clinic. Robbed at first by the Japanese and later by the Indonesian Nationalists, the university library has been depleted of nearly all its books. Reprints and texts would be most welcome. To assist in the payment of shipping literature abroad, a fund has been set up by Mrs. Elizabeth Proctor and is administered by Miss Jeanette Loessl, Howe Library, Massachusetts Eye and Ear Infirmary, 243 Charles Street, Boston. Books and other literature should be sent either to this address, with instructions for whom they are intended, or directly to Dr. J. C. van Manen, Universiteit van Indonesie, Geneeskundige Facultiet, Salemba 6, Batavia-C.

Twenty-First Annual Spring Graduate Course, Gill Memorial Eye, Ear and Throat Hospital.—The twenty-first annual spring graduate course, Gill Memorial Eye, Ear and Throat Hospital, will be given the week of April 5 through April 10, 1948. Among the guest speakers in ophthalmology will be: Prof. Adalbert Fuchs, UNRRA-WHY, Nanking, Shanghai, China; Dr. Conrad Berens, 35 East Seventieth Street, New York; Dr. A. D. Ruedemann, Wayne University College of Medicine, Detroit; Dr. Edwin B. Dunphy, Massachusetts Eye and Ear Infirmary, Boston; Dr. Trygve Gundersen, 101 Bay State Road, Boston; Dr. John M. McLean, 525 East Sixty-Eight Street, New York; Dr. Alston Callahan, Medical College of Alabama, Birmingham, Ala.

Abstracts from Current Literature

Experimental Pathology

SOME EFFECTS OF VITAMIN-A DEFICIENCY ON THE EYE OF THE RABBIT. I. MANN, A. PIRIE, K. TANSLEY and C. WOOD, Am. J. Ophth. **29:** 801 (July) 1946.

A study of biomicroscopic and histologic changes in the eyes of vitamin A–deficient rabbits correlated with vitamin A levels of the plasma substantiated the observations of earlier workers that the ocular changes are primarily in the conjunctiva and epithelium of the cornea. Keratinization of the cornea and conjunctiva clears up rapidly on treatment with vitamin A, but removal of conjunctival pigment and reestablishment of the conjunctival mucous cells take place more slowly.

W. S. REESE.

RELATION BETWEEN MATERNAL VITAMIN-A INTAKE, BLOOD LEVEL, AND OCULAR ABNORMALITIES IN THE OFFSPRING OF THE RAT. B. JACKSON and V. E. KINSEY, Am. J. Ophth. **29:**1234 (Oct.) 1946.

Jackson and Kinsey conclude that ocular defects occur in the young rat only when the maternal vitamin A deficiency is extremely severe—so advanced, in fact, that fetal resorption is common and normal birth is impossible.

To the extent that the physiologic processes associated with reproduction in human beings parallel those in the rat, it may be inferred that vitamin A deficiency in the mother is not a probable cause of retrolental fibroplasia.

W. S. REESE.

General Diseases

STEVENS-JOHNSON'S DISEASE. W. Y. JONES, F. F. TALBOT and W. F. KING, Am. J. Ophth. **29:**185 (Feb.) 1946.

A case of Stevens-Johnson disease occurring in a woman aged 56 is reported. The authors believe that the name Stevens-Johnson disease should be reserved for those cases of erythema exudativum multiforme exhibiting a purulent conjunctivitis.

W. ZENTMAYER.

MEDICAL SIGNIFICANCE OF OCULAR TORTICOLLIS. J. W. SMITH, Bull. Hosp. Joint Dis. **6:**99 (Oct.) 1945.

Ocular torticollis may be defined as a compensatory adjustment, tilt or position of the head to overcome vertical diplopia. In the diagnosis of paresis of the vertically acting muscles, the eyes of the ophthalmologist must be on the same level as those of the patient. Palpation for tightness or gross enlargement of the sternocleidomastoid muscle and examination for skeletal defects should be made. Relaxation of the patient is

best obtained by examining the patient's back. Photographs should be made against a graph for better showing of the degree of head tilt and ocular torticollis before and after operation. Interdepartmental consultations are important in the differential diagnosis of congenital and ocular torticollis. Operations for convergent and divergent strabismus should not be performed until the action of the vertically acting muscles have been studied carefully. Head tilt and other skeletal changes are presumptive evidence of vertical muscle imbalance. Smith describes a graph of his own designing.

W. ZENTMAYER.

Glaucoma

PREGLAUCOMA. H. S. GRADLE, Am. J. Ophth. **29**:520 (May) 1946.

Gradle divides preglaucoma into two forms, that which precedes acute glaucoma and that which is followed by chronic glaucoma. They can be differentiated clinically but require different types of provocative tests for confirmation. When recognized, preglaucoma necessitates preventive treatment.

W. S. REESE.

CYCLODIALYSIS IN THE TREATMENT OF GLAUCOMA. S. D. MCPHERSON, Am. J. Ophth. **29**: 848 (July) 1946.

McPherson analyzed 140 cases of chronic primary glaucoma, glaucoma following cataract extraction and glaucoma secondary to uveitis, treated with cyclodialysis. Tension was brought below 30 mm. of mercury (Schiøtz) in 42 per cent of the cases of primary glaucoma, in 35.9 per cent of cases of glaucoma following cataract extraction and in 6.5 per cent of the glaucoma secondary to uveitis. The operation was more effective in eyes with deep anterior chambers, and failure to reduce the tension to normal was likely to be evident in the first postoperative month.

W. S. REESE.

TREATMENT OF GLAUCOMA WITH DI-ISOPROPYL FLUOROPHOSPHATE (DFP). P. R. MCDONALD, Am. J. Ophth. **29**:1071 (Sept.) 1946.

McDonald successfully controlled glaucoma with diisopropyl fluorophosphate (DFP) in 57.4 per cent of a series of 122 eyes, in which the disease had previously been uncontrolled. He found it more powerful than any other miotic and its action prolonged; it does not cause local irritation, and it appears especially effective in treatment of aphakic glaucoma.

W. S. REESE.

POSTERIOR SCLEROTOMY AND LENS EXTRACTION IN ACUTE GLAUCOMA SECONDARY TO SENILE CATARACT. P. J. KENNEDY, Pennsylvania M. J. **49**:742 (April) 1946.

Six patients with glaucoma secondary to senile cataract were treated by complete minimal posterior sclerotomy, followed in ten minutes by combined extraction of the lens. The results have been good. The method would seem to warrant further use before its value can be definitely ascertained. The main complications—hypotony immediately following the sclerotomy—can be controlled by careful surgical technic.

W. ZENTMAYER.

Hygiene, Sociology, Education and History

NINETEENTH CENTURY PROVINCIAL EYE HOSPITALS (WITH SPECIAL REFERENCE TO THOSE NO LONGER EXTANT). A. SORSBY, Brit. J. Ophth. **30**:501 (Sept.) 1946.

Records are extant of the founding of 19 ophthalmic hospitals between 1808 and 1832. Of these, 11 have survived and 8 have become defunct. The 11 survivors are now all venerable institutions, some being of considerable importance. The distribution of these 19 ophthalmic institutions shows that they were largely concentrated in the declining, but still populous, southwestern area of England and in the rapidly growing northern belt. Between 1834 and 1861, 15 ophthalmic institutions were established, and of these 6 have survived. Southwest England still claimed a considerable development, but the Midlands now figured prominently. Between 1866 and 1889, 18 ophthalmic institutions were founded, and of these 6 have survived. A brief, concise history of these institutions is given, with biographic notes on ophthalmologists connected with the institutions no longer extant. This study represents a very considerable piece of work, occupying about fifty pages of the journal.

W. ZENTMAYER.

OPHTHALMOLOGY IN LECTURES OF A CENTURY AGO. R. R. JAMES, Brit. J. Ophth. **30**:658 (Nov.) 1946.

James gives a few ophthalmic excerpts from lectures delivered at St. Bartholomew's Hospital by Abernethy. His main thesis in ophthalmology is in operative surgery. He tells of an accident to himself when riding. The horse threw up his head, and Abernethy received a pretty severe blow on the nose. Soon after having squeezed the nasal bones into their proper places, he noticed an eclipse of the third of every object on the right side. He records his observations thus: "If I saw . . . *A-ber-ne-thy* in a bookseller's shop window, I could see *A-ber-knee,* but I could not see the *thigh* at all. . . . Let those [who] account for it as arising from a decussation of the nerve, do it; My own opinion is, that it arises, from the *irregular actions of the retina.*"

W. ZENTMAYER.

Injuries

THE MANAGEMENT OF INTRAOCULAR FOREIGN BODIES IN MILITARY PRACTICE. G. M. HAIK, Am. J. Ophth. **29**: 815 (July) 1946.

Haik reviews 81 cases of intraocular foreign body dealt with under wartime conditions. He emphasizes the roentgenologic and surgical methods particularly and remarks the increase in these injuries from highly mechanized warfare.

W. S. REESE.

ARSENICAL EYE BURNS. G. I. UHDE, Am. J. Ophth. **29**:1090 (Sept.) 1946.

Uhde found British BAL (2,3-dimercaptopropanol) completely effective in preventing the serious effects of lewisite (dichlorobetachlo-

rovinylarsine) on the eye if used within two minutes after contamination. It is less effective against mustard gas (dichloroethyl sulfide), in cases in which irrigation is indicated.

W. S. REESE.

Lens

OBSERVATIONS ON THE VOSSIUS RING. T. GUNDERSEN, Am. J. Ophth. 29:837 (July) 1946.

Gundersen reports 19 cases of Vossius ring formation, in all of which the size of the ring was practically constant. He believes that this ring is due to deposition of blood pigments during interchange of fluids through the anterior capsule of the lens.

W. S. REESE.

Neurology

OPHTHALMIC SYNDROMES ASSOCIATED WITH FRONTAL TUMORS. M. A. DIEZ, Arch. de oftal. de Buenos Aires 20:267 (July-Aug.) 1945.

Tumors of the frontal lobe produce ocular symptoms which can be detected objectively by observation of the fundus and subjectively by study of the visual field.

Diez has studied 10 cases verified by operation and anatomopathologically. Their period of evolution from the appearance of the first subjective symptoms ranged from three months to nine years. Headaches and failing vision were the usual initial symptoms.

The ophthalmologic diagnosis of these tumors may be based on the following findings: moderate exophthalmos; widening of the palpebral fissures; nystagmus on extreme ocular movement; central arterial hypertension (above 50 mm.); bilateral papilledema, more marked on the side of the tumor (or with changes denoting a disturbance of longer standing); diminished visual acuity and enlargement of the blindspot on the side of the tumor; incongruent contraction of the peripheral visual fields in the majority of cases and, at times, binasal or bitemporal hemianopsias and central scotoma.

The 10 cases studied are described in detail. A table with the features of each case, their retinograms and visual fields, appears in the article.

H. F. CARRASQUILLO.

Pharmacology

THE INFLUENCE OF VEHICLES AND FORM OF PENICILLIN AND SULFONAMIDES ON MITOSIS AND HEALING OF CORNEAL BURNS. G. K. SMELSER, Am. J. Ophth. 29:541 (May) 1946.

Smelser found that when a sulfonamide powder is 100 to 200 mesh decided inhibition of corneal healing occurs, this inhibition being greater with sulfacetimide than with sulfadiazine or sulfathiazole. Hydrosorb fatty acid esters of diethanolamine with petrolatum and hydrous wool fat U.S.P. were the least harmful of the ointment bases in inhibiting the healing of corneal burns, and this inhibition was not increased by the

addition of penicillin. Solid penicillin was harmful, but calcium penicillin powder suitably diluted with lactose caused no inhibition in itself.

W. S. REESE.

Retina and Optic Nerve

RETINAL HEMORRHAGE AS SEEN IN AN ATOMIC-BOMB CASUALTY. K. B. BENKWITH, Am. J. Ophth. **29:799** (July) 1946.

Benkwith reports the case of a 14 year old Japanese girl who suffered excessive gamma ray irradiations, producing her clinical picture. She was about 1 mile (1.6 kilometer) from the hypocenter of the atomic bomb at Nagasaki in her home, which was demolished. Her fundi showed massive preretinal hemorrhages and hemorrhages into the fiber layer of the retina. These were distributed around the disk and in close association with the retinal vessels for approximately 3 disk diameters peripheral to the disk. Small, fluffy, white exudates were scattered about the disk and in close approximation to the retinal vessels of greater caliber. She was pronounced well at the turn of the year.

W. S. REESE.

MACULAR EDEMA. A. J. BEDELL, Am. J. Ophth. **29:** 1228 (Oct.) 1946.

Bedell concludes that edema of the macular region may be the isolated expression of a local or a general tissue reaction. The edema may be limited to and disappear from the macula, or it may be the precursor of an extensive retinochoroiditis or gross macular change. The healed macula may show pigmented specks, white dots, heaped-up pigment, atrophy or thick scars, which may be smooth and flat, or rough and nodular.

W. S. REESE.

CHANGES IN THE ANGIOSCOTOMAS ASSOCIATED WITH THE ORAL ADMINISTRATION OF EVIPAL [SOLUBLE HEXOBARBITONE]. A. I. FINK, Am. J. Ophth. **29:** 1258 (Oct.) 1946.

In 8 of 10 subjects Fink observed a widening of the angioscotoma after the administration of 4 grains (0.26 Gm.) of soluble hexobarbitone (*n*-methylcyclohexanylmethylmalonylurea, or "evipal").

W. S. REESE.

TREATMENT OF RETINITIS PIGMENTOSA WITH INTRAMUSCULAR INJECTIONS OF COD LIVER OIL. V. P. FILATOV and V. A. VERBITSKA, Am. Rev. Soviet Med. **3:388** (June) 1946.

Filatov and Verbitska gave intramuscular injections of cod liver oil to 12 patients with retinitis pigmentosa. The patients were between the ages of 15 and 50 years. Rapid improvement, manifested by an increase in acuity of vision and in light sensitivity resulted in some instances after one or two injections. The increase in light sensitivity after treatment with cod liver oil was superior to that resulting from

other methods; in 1 patient the light sensitivity was increased one thousand times, in another patient fifty times and in 5 patients ten times. Good results were obtained with severe chronic forms of the disease. Although the patients reported on could not be followed for a long enough period to permit final conclusions with regard to prolonged treatment or repeated injections at intervals, the parenteral use of cod liver oil in the treatment of retinitis pigmentosa proved highly effective and deserves further study.

J. A. M. A. (W. ZENTMAYER).

RETINAL DETACHMENT DUE TO WAR TRAUMA. H. B. STALLARD, Brit. J. Ophth. **30**:419 (July) 1946.

This inquiry was made to find out the incidence of retinal detachment directly attributable to the effects of war missiles, the relation of this incidence to that of other types of retinal detachment occurring in soldiers serving in a field force and the comparative results of treatment and prognosis. Retinal detachment due to trauma from military missiles is rare. Twenty cases of military trauma are analyzed. In 17 cases of military trauma in which operation was performed there were 11 successes and 6 failures; in 26 cases of trauma of civilian life, 23 successes and 3 failures; in 26 cases of choroido-retinal degeneration, 26 successes and no failures; in 16 cases of cystic degeneration, 16 successes and no failures, and in 8 cases of myopia, 6 successes and 2 failures. In 1 case of military trauma the ocular damage was considered too hopeless to benefit by operation, and in 2 others spontaneous recovery occurred. The reason for the comparatively poor results in cases of military trauma are the gross intraocular damage done to eyes by the severe contusion effects of war missiles traversing the orbit or parts of the cranium and face near the orbit. The intraocular pressure is considerably reduced more than with other types of retinal detachment.

W. ZENTMAYER.

BILATERAL SYMMETRICAL CYSTIC DETACHMENT OF THE RETINA. H. B. STALLARD, Brit. J. Ophth. **30**:547 (Sept.) 1946.

Stallard reports on 2 cases of bilateral symmetric cystic detachment of the retina, preequatorial in the upper temporal quadrant of each eye. In both cases the cysts were symmetric in size, shape and position. In 1 case the cystic detachment in the right eye had spontaneously disappeared, the retina was replaced and there was no retinal hole. The periphery of the cyst in this case was marked posteriorly by a broad, grayish white crescent, and the area of retina which had formed the thin, stretched cystic wall, and was now replaced, showed a slightly deeper red fundus reflex than the rest of the fundus. This appearance of the fundus was precisely that seen after successful reposition of the cystic detachment by surgical measures. In neither case was there any family history of cystic detachment or any congenital ocular or other defect. The eyes of both patients were normal except for the cystic detachment. One had a low degree of myopia, and the other was emmetropic. The vitreous appeared normal, and there were no congenital defects in the eyes or elsewhere in the body. A single application of surface diathermy

was made near the most dependent part of the cyst, about halfway between the equator and the ora serrata. Through this site a single puncture was made with a fine, penetrating diathermy needle 1.5 mm. long. The cystic fluid was effectively evacuated, and postoperative recovery was uneventful. The retina was replaced in the 3 eyes operated on.

W. ZENTMAYER.

CHORIORETINITIS JUXTAPAPILLARIS (JENSEN). J. W. C. VERHAAGE, Ophthalmologica **111:** 351 (June) 1946.

The author reports a case of juxtapapillary chorioretinitis (Jensen) in which there were prominent lesions of the veins, together with deposits of cholesterol in one retina. The opposite eye also showed signs of healed periphlebitis of the retina. In the author's opinion, both the periphlebitis of the retina and the juxtapapillary choroiditis were due to a tuberculous infection. He considers the choroiditis as due primarily to periphlebitis.

F. H. ADLER.

Trachoma

SULFONAMIDES AND PENICILLIN IN THE TREATMENT OF TRACHOMA. F. S. LAVERY, Brit. J. Ophth. **30:**591 (Oct.) 1946.

Fifty-four cases of trachoma are analyzed as to the result of treatment with sulfonamide compounds and penicillin. In the cases selected for penicillin therapy the drug was administered locally in the form of drops, with a concentration of 2,500 units per cubic centimeter. Only cases in which inclusion bodies were observed, either before or after treatment, were considered. It is of importance that in 3 cases inclusion bodies were identified after carefully controlled sulfonamide therapy. On the other hand, the absence of inclusion bodies in 5 of 8 cases after the conclusion of sulfonamide therapy against their absence in 1 of 5 cases in which penicillin therapy was used can hardly be fortuitous. The sulfonamide compounds were administered internally and locally.

W. ZENTMAYER.

Tumors

GLIOMA OF THE OPTIC NERVE. M. MANNHEIMER, Am. J. Ophth. **29:** 323 (March) 1946.

Mannheimer reports a case of glioma of the optic nerve. Intracranial section of the nerve was first performed, followed by enucleation and extirpation of the remaining nerve.

W. S. REESE.

EXOPHTHALMOS CAUSED BY EOSINOPHILIC GRANULOMA OF BONE. M. WHEELER, Am. J. Ophth. **29:** 980 (Aug.) 1946.

Wheeler reports the case of a man aged 34 who had a tumor of the right orbit which had caused erosion of the roof. The growth was removed and proved to be eosinophilic granuloma of bone.

W. S. REESE.

AN UNPIGMENTED PRIMARY TUMOUR OF THE OPTIC DISK. J. P. WHITE and A. LOEWENSTEIN, Brit. J. Ophth. **30: 253** (May) 1946.

The growth was first observed when the boy was 7½ years old. Vision equaled 6/36. The upper two thirds of the disk of the left eye was covered by a whitish, smooth mass of 2 disk diameters. The child was intelligent, well built and well nourished. At the age of 9 years the disk was covered by a grayish white, oval mass with a smooth surface. The margins of the tumor were tuberous and rose steeply from the fundus (+1 D.) to a height of 8 D. A small portion was vascular. The nasal part of the mass was covered by hemorrhages. There was scattered pigment in the lower half of the fundus, with depigmented spots and superficial hemorrhages. The pigment was predominantly in the deeper retinal layers. The fundus of the right eye showed similar changes. Histologic investigation showed a tissue consisting of large, foamy cells, the contents of which were neither fatty nor mucinous. The nature of the regressive process was not determined. The tumor tissue infiltrated the surrounding retina, the posterior layers of which were missing and were perhaps undeveloped. There was a cavernous degeneration in a large part of the optic nerve. The caverns were empty or filled with a fine foamy substance. A film of subhyaloid blood covered wide areas of the retina. The growth is explained as a phakoma arising from the neuroectodermal cells of the optic stalk, into which the fibers of the retinal ganglion cells grow. As the two layers of the optic stalk consist of potentially pigment-producing cells (the outer layer) and nonpigmented cells (the inner layer), misplacement of either of them may be responsible for the growth of pigmented or nonpigmented phakoma of the disk. The existence of both malformations can be proved. The article is well illustrated.

W. ZENTMAYER.

A CASE OF CHONDROMA BULBI. A. AJO, Brit. J. Ophth. **30: 465** (Aug.) 1946.

The patient, a youth aged 19, stated that the condition of the left eye had always existed. Two small movable soft tumors were present in the subconjunctival tissue; both extended over the limbus and infiltrated the corneal parenchyma. The eye had remained quiet until the age of 17. The growths were removed and proved to be chondroma without signs of malignancy. One year later there was a recurrence; the cornea was surrounded by new growth, which infiltrated the corneal tissue. The article is illustrated.

W. ZENTMAYER.

Uvea

SYNDROME OF UVEITIS, MENINGO-ENCEPHALITIS, ALOPECIA, POLIOSIS, AND DYSACOUSIA. R. D. HARLEY and E. S. WEDDING, Am. J. Ophth. **29:** 524 (May) 1946.

Harley and Wedding report a case of uveitis, meningoencephalitis, alopecia, poliosis and dysacousia in which actinomycetes were recovered

from the aqueous and the spinal fluid. They suggest that this organism initiated liberation of pigment from the irises, which resulted in sensitization to pigment of the uveal tract, and possibly other pigmented structures. The fact that the organism was similarly obtained from the spinal fluid presents the possibility that the pigmentary disturbance was of central origin, in the region of the hypothalamus. W. S. REESE.

BILATERAL UVEITIS WITH RETINAL DETACHMENT, POLIOSIS, ALOPECIA, and DYSACOUSIA. J. LAVAL, Am. J. Ophth. **29**:536 (May) 1946.

Laval reports the case of a woman aged 42 who had difficulty in reading. Examination revealed nothing significant except for a few cells in the aqueous of each eye. She then had a pronounced increase in the hyperopia, evidently from retinal edema, which eventuated in a bilateral detachment. Loss of hair, loss of hearing and uveitis then became apparent, and finally secondary glaucoma developed, which required operation on both eyes. W. S. REESE.

BILATERAL DETACHMENT OF THE CHOROID OF UNUSUAL DURATION FOLLOWING CORNEO-SCLERAL TREPHINE. A. E. P. PARKER, Brit. J. Ophth. **30**:595 (Oct.) 1946.

A woman aged 56 had a history of poor health and myxedema. Vision was 6/18 in the right eye and 6/12 in the left eye. Tension was 1 plus. The fields were contracted. Under treatment with miotics vision improved and the tension was consistently about 30 mm. (Schiøtz). As the fields continued to contract, a trephination with a small complete iridectomy was done on the right eye and the conjunctival flap sutured with a continuous suture. A few days later the choroid was detached in the upper nasal quadrant. The separation persisted about nine months; tension was 15 mm. About four months after operation on the right eye trephination was done on the left eye, and only a peripheral iridectomy was done. The choroid became detached in the upper nasal quadrant and remained so for about five months. Tension was 12 mm. The complication has apparently had no permanent adverse effect. Parker considers that the dominant feature in this case was the low tension. It might be wise to treat glaucoma with low tension by iridencleisis or cyclodialysis. W. ZENTMAYER.

Therapeutics

USE OF HEPARIN IN TREATMENT OF THROMBOSIS OF THE CENTRAL VEIN OF THE RETINA. G. CIOTOLA, Boll. d'ocul. **24**:35, 1945.

Thirty-five cases of thrombosis of the central vein of the retina treated with intravenous injections of 150 mg. of heparin (twice daily) are reviewed. The results obtained were as follows: In 1 case central visual acuity was decidedly improved; in 5 cases visual acuity became worse; in 1 case hemorrhagic glaucoma developed; in 12 cases some degree of improvement in central visual acuity occurred. In the remaining 16 cases the condition remained stationary. G. BIETTI.

TREATMENT OF RETINITIS PIGMENTOSA WITH AUTOCLAVED EXTRACT OF ALOE. V. SKORODINSKAYA, Vestnik oftal. **25:** 0, 1946.

Skorodinskaya observed the therapeutic effect of aqueous extract of conserved leaves of aloe on retinitis pigmentosa in 12 cases, or 24 eyes. In 8 of these cases deafness was also present. The extract was given subcutaneously, in a dose of 1 or 2 cc. either daily or every other day, until a total of twenty-five to forty-five injections had been made. In 1 case the extract was used in the form of enemas (which is a convenient method in children). In 2 cases implantation of the leaves of aloe (size 3 or 4 cc.) was used in addition to the injections. In 1 case an implantation of conserved heterogenous skin was added to the course of injections of extract of leaves of aloe.

In all but 1 case there were improvement of vision (from 0.1 to 0.4; from 0.2 to 0.5) and enlargement of the visual fields, in some cases in the form of islands at the periphery. Dark adaptation improved last. The treatments had to be repeated every two or three months, as vision began to decrease at the end of three months. The time of observation was from seven to eighteen months. The treatment proved to be beneficial to the general condition of the patients, producing improvement of hearing, better regulated menstrual periods, better appetite and less fatigability.

O. SITCHEVSKA.

Society Transactions

EDITED BY DR. W. L. BENEDICT

SECOND PAN-AMERICAN CONGRESS OF OPHTHALMOLOGY

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Montevideo, Uruguay, Nov. 26 to Dec. 1, 1945

PREVENTION OF BLINDNESS IN THE AMERICAS

Report of the Committee for the Prevention of Blindness of the Pan-American Congress of Ophthalmology. DR. FRANCISCO BELGERI, president, and DR. BAUDILIO COURTIS, secretary, Buenos Aires, Argentina.

The committee reported on the replies that had been received from the questionnaire sent to the delegates in each country of the Western Hemisphere. From the data assembled the committee concluded that much work is to be done before a uniform program for the prevention of blindness becomes a reality. They proposed a minimum program as the first step in the prevention of blindness in the Americas and suggested that the Pan-American Congress sponsor this program through government agencies and medical groups of each country. The committee would organize as part of this plan an information bureau, where data on each local program could be assembled and material such as films, documents and pamphlets could be exchanged.

Causes of Uniocular and Binocular Blindness in the United States Navy and United States Marine Corps During World War II. CAPT. C. A. SWANSON (MC), U.S.N.

Captain Swanson reported on 759 cases of blindness that had occurred during the war years up to 1944. Of these cases, blindness was bilateral in 119 and unilateral in 640. For practical purposes, blindness was considered as corresponding to uncorrected vision of 20/200 or less, or a permanent narrowing of the visual field of 15 degrees or less. Of the bilateral cases, blindness was due to wounds received in combat in 72, to accidental wounds in 12 and to disease in 35. Of the unilateral cases, blindness was due to combat wounds in 322, to accidents in 143 and to disease in 126. The author pointed out the seriousness of intraocular foreign bodies in military ophthalmology and reviewed the methods of handling them. In 50 per cent of the cases of intraocular foreign body enucleation was necessary.

Prevention of Blindness. Prof. A. Vázquez Barriere, Montevideo, Uruguay.

Professor Vázquez Barriere pointed out that "blindness is a social calamity" and that it is preventable in 70 per cent of cases. He expressed the belief that the state, through legal enforcement of prophylactic measures and dispersion of educational material concerning preventive measures, should take a more active part in the conservation of vision of its populace. It was proposed that the Pan-American Congress suggest to all the governments of the Americas the advantage of having assembled in a "Sanitary Digest for Prevention of Blindness" all the hygienic precepts and prophylactic measures necessary for such a program. The author outlined in detail the measures necessary for the prevention of blindness resulting from heredity, infections, trauma, intoxications, lack of medical attendance and visual work effected under defective conditions.

Basic Work in Establishment of a "Code for Illumination." Dr. Salvador Masson, Montevideo, Uruguay.

The author directed attention to the research being done by investigators and scientific institutions to provide correct illumination for schools, office buildings and industrial establishments. Since many defects of vision begin during the student days, it was suggested that more emphasis be placed on the teaching of "prophylaxis of defective eyesight" to students in elementary schools.

Statistics in the Prevention of Blindness. Prof. Baudilio Courtis, Buenos Aires, Argentina.

This paper was not available for abstracting.

CAMPAIGN AGAINST TRACHOMA IN THE AMERICAS

Report of the Committee on Trachoma of the Pan-American Congress of Ophthalmology. Prof. Dr. Ivo Corrêa Meyer, Porto Alegre, Brazil.

Attention was called to the magnitude of the problem in collecting data on the incidence and distribution of trachoma in the Americas. Through the diligence of members of this committee, data on the United States and Canada were assembled by Dr. Phillips Thygeson; on Central America, by Dr. P. Richards; on Argentina, Uruguay, Bolivia, Chile and Paraguay, by Dr. J. A. Senà; on Peru, Ecuador, Colombia and Venezuela, by Dr. J. Valdeavallano, and on Brazil, by Dr. Silvio de Almeida Toledo. The number of cases of trachoma in the Americas was estimated to be 1,000,000. The "trachomatous nuclei" of the United States, Brazil and Argentina were most important. Smaller nuclei were found in Chile, Mexico, Cuba and Paraguay. In such countries as Uruguay, Bolivia and Peru trachoma was of little importance. In many others, such as Guatemala and Costa Rica, trachoma was unknown.

In Canada most of the cases of trachoma were observed in the southern and western provinces. Although no state in the United States was completely free of trachoma, 70 per cent of the cases seemed localized to Virginia, Kentucky, Tennessee, Illinois and Missouri. A minimum of 25,000 cases among the North American Indians was estimated.

In Brazil the disease was chiefly localized in three areas, namely, the northeastern section, the state of São Paulo and the colonial region of the state of Rio Grande do Sul. Until 1943, when the federal government launched a campaign against trachoma, eradication of the disease was in the hands of the state governments.

In Argentina trachoma was endemic in the northern population, but the capital, Buenos Aires, was considered entirely free. The Argentine government was taking steps to eradicate the disease, especially among school children.

The committee proposed that investigations be carried out in the various countries on the prophylactic value of the new chemotherapeutic products, particularly the sulfonamide compounds.

Etiology of Trachoma. Dr. Phillips Thygeson, New York.

The author said that trachoma was caused by a virus of large particle size, belonging to the psittacosis-lymphogranuloma venereum group. The virus appears to be strictly epitheliotropic, and no proof has yet been offered that it occurs in human cells other than the conjunctival and corneal epithelium. Research on this virus is handicapped by the difficulties of culture on living tissues, the absence of a suitable laboratory animal and the difficulty of obtaining material with an adequate concentration of the virus.

Recent Acquisitions in Therapy of Trachoma. Dr. José A. Senà, Buenos Aires, Argentina.

The chronic evolution, the varied clinical aspects and the latent periods characteristic of trachoma make it difficult to assess a cure. However, it now seems indisputable that the sulfonamide compounds have a beneficial effect on the disease.

Trachoma in Guatemala. Dr. R. Pacheco Luna, Guatemala, Guatemala.

The author pointed out that trachoma is not observed among the natives of Guatemala. He stressed the fact that trachoma among the foreign population is not transmissible to native wives, half-breed children or Indian servants. Although every condition favorable for the propagation of trachoma is present, the apparent racial immunity prevents this disease from becoming a problem.

Trachoma: Triple Application of Sulfanilamide. Dr. J. Lijo Pavía and Dr. R. Lachman, Buenos Aires, Argentina.

The authors reported 4 cases in which sulfanilamide was administered by mouth, instilled locally in solutions of 10 per cent and 25 per cent strength and applied locally as a fine powder. Biopsies of the affected conjunctiva before and after treatment revealed the beneficial effects of this method of therapy.

Trachoma in Pernambuco, Brazil. Prof. Francisco Figuerêdo and Dr. Altino Ventura, Pernambuco, Brazil.

Of the 15,200 patients treated at the clinic and hospital in Pernambuco, approximately 16.50 per cent had trachoma. The authors formu-

lated a plan for the treatment and prevention of trachoma. This plan, from the north of Brazil, was the first to be submitted in the campaign against trachoma.

Organization of Campaign Against Trachoma in the State of São Paulo (Brazil). DR. SILVIO DE ALMEIDA TOLEDO, São Paulo, Brazil.

Dr. Silvio de Almeida Toledo, director of the trachoma service of the Department of Health of the State of São Paulo, described his organization of services for the prophylaxis of trachoma throughout the territory during the period of 1943 to 1945 (January to June) and gave a statistical analysis of 435,818 cases of the disease enrolled in the trachoma dispensary units.

The author discussed in detail (*a*) medical and sanitary assistance, with respect to attendance, recoveries, operations and laboratory tests; (*b*) epidemiology, with respect to types of trachoma and nationality, color, sex and profession of patients; (*c*) trachoma and blindness; (*d*) trachoma and biologic tests; (*e*) trachoma and climatic and geographic conditions, and (*f*) trachoma and contagion, ending with a study of statistics on prevalence and infection.

CONTACT LENSES

Plastic Contact Lenses. PROF. DR. BAUDILIO COURTIS, Buenos Aires, Argentina.

The author stated "that every eye for which a contact lens is indicated can tolerate such a lens" provided the proper adjustments have been made. Molding the plastic material to the eyeball is unnecessary with use of the trial box of thirty lenses which the author recommended. The prescription of a contact lens begins with measurement of the corneal radius with the ophthalmometer. The corneal diameter and the scleral radius are next measured. Examination of the contact lens in position with a 2 per cent solution of fluorescein sodium and cobalt light is necessary to correct any maladjustments. A final mold of the finished lens should be made in case it is necessary to reproduce it for any reason.

Stereophotographic Measurement of the Anterior Segment of the Eye. DR. ENRIQUE V. BERTOTTO, Rosario, Argentina.

The author reported on the progress being made in photography of the curvatures of the anterior segment. The accurate photographic measurement of the corneal and conjunctival curvatures makes it possible to produce a contact lens with a larger base resting on the conjunctiva. Additional advantages of this method are as follows: Compression on the eye is avoided; the eye is not touched, and the height of the cornea is more accurately determined. After the eye is anesthetized, the conjunctiva is dusted with powdered charcoal to make this tissue visible on the photographic plate. The photographic measurement is based on the principle that each point of space is fixed on two photographic plates. Once the distance between the objectives, the distance between the objectives and the plates and the distance from the center of the plates to the image are known, the exact position of any point on the anterior segment of the globe can be obtained through a proportional equation.

Present Day Plastic Contact Lenses. Dr. Eduardo Amoretti, Córdoba, Argentina.

The author stated that the use of plastic contact lenses is the best method for the exact correction of most errors of refraction. Plastic contact lenses of spherical revolution and toric lenses can be used with success in certain cases. Further work should be done in regard to the appropriate solutions to be used with the current lens. The author appealed for further investigation on the cause of keratoconus.

GONIOSCOPY

Gonioscopy and Goniometry: Their Applications and Limitations. Dr. H. Saul Sugar, Detroit.

The author presented a short description of the technic of gonioscopy and stressed the anatomic points to be observed with this method of examination. The trabecular band extending from the termination of Descemet's membrane to the anterior edge of the ciliary body is important from the functional standpoint. Schlemm's canal is not usually visible. The optical illusions created by the distortion of the globe by the contact lens were mentioned. Gradle and Sugar measured the angle of the anterior chamber by calculating the length of an imaginary perpendicular line drawn from the limits of Descemet's membrane to the iris.

Gonioscopy has its practical application in the study of pathologic processes of the limbus and anterior chamber and in the study of glaucoma. The method is an aid in differentiating the congestive attacks of primary glaucoma from the congestive phase of secondary glaucoma. Gonioscopy has shown that in cases of so-called primary glaucoma two clinical signs can be distinguished: the narrow angle and the normal or wide angle.

Gonioscopy. Prof. Dr. Jorge Valdeavellano, Lima, Peru.

Study of the angle of the anterior chamber was begun by Trantas in 1899 and was pursued by Salzmann and Koeppe. In 1925 Uribe Troncoso invented the gonioscope and used it with the contact lens. Gonioscopy, by permitting a detailed examination of the angle of the anterior chamber, enables one to study one of the factors which contribute to the control of intraocular pressure. From a surgical viewpoint, gonioscopic study helps in determining the appropriate zone for good drainage and may reveal the reason for failure of a filtering operation.

New Concepts of Glaucoma Derived from Gonioscopy. Dr. Peter Kronfeld, Chicago.

Gonioscopy has confirmed the mechanism of two well known types of glaucoma: the one due to iris block, and the other to peripheral synechias following retarded formation of the anterior chamber, either postoperative or post-traumatic. With regard to corneoscleral trephining, gonioscopy has revealed that eyes wth wide angles and free from

peripheral synechias are most favorable for this operation, that the most favorable site for the trephination is halfway between the entirely corneal and the mostly scleral position and that the majority of the complications are due to a too rapid decompression. With iridencleisis, an appreciable separation of the internal edges of the wound occurs in 79 per cent of the successful cases and in 62 per cent of the cases of failure. In cyclodialysis a successful operation is assured with a superciliary cleft communicating with the anterior chamber and extending over at least 45 degrees on the dial. Iridectomy is successful only in cases of narrow angle glaucoma and of certain secondary glaucomas.

GLAUCOMA

Preglaucomatous State. DR. HARRY S. GRADLE, Chicago.

In 1924 the author proposed the term "preglaucoma" for the conditions in which ocular hypertension is expected to occur in the course of time. Two types of hypertension can be foreseen: the narrow angle type, with manifestations of acute, uncompensated glaucoma, and the wide angle type, with an insidious beginning. It is important to distinguish between the two types, as provocative tests may prove disastrous in cases of the first type.

In consideration of the eyes in which acute hypertension may develop, the patient's history is of great importance. The patient is rarely under 45 or over 70. Myopia in these patients is rare. The iris which is somewhat thicker and the iris in which dilation of the pupil causes an increased thickness of the base predispose to acute hypertension. In eyes which have had previous prodromal attacks a few traces are usually left, such as slight mydriasis with oval deformation of the pupil or partial atrophy of a sector of the iris.

Greater care is required to discover preglaucoma of a chronic type. The case history furnishes less useful data, and the age range is greater. Gonioscopic examination reveals an open angle with particles of pigment embedded in the trabeculae in some cases. The pupil tends to dilate with a facility unusual in normal eyes. Frequently there is enlargement of the blindspot of from 1 to 5 degrees, for which there is no explanation.

When glaucoma is suspected, provocative tests must be resorted to. These tests are based on the increase in tension stimulated by various well known procedures, the most useful being the drinking test or the use of a weak mydriatic, which produce an increase up to 8 mm.

A 1 per cent solution of pilocarpine nitrate instilled on retiring may be used in the preglaucoma state.

Estimation and Mechanism of the Destructive Effects of Ocular Hypertension. DR. AMADEO NATALE, Buenos Aires, Argentina.

The various theories of formation of the aqueous humor and the system of drainage of the intraocular liquids were reviewed. The relative parts played by the several anatomic structures both in the production and in the drainage of the intraocular fluids were mentioned. Many observations and experimental data have been accumulated to explain the etiology and physiopathology of glaucoma, but no one has been able to arrive at a theory which is in accord with all the known factors.

DISCUSSION

DR. SILVIO DE ABREU FIALHO, Rio de Janeiro, Brazil: Intraocular hypertony is the primary and fundamental cause of the visual decrease in glaucoma, although accessory factors can produce a slower or a more rapid onset of the hypertony. An especially intense compressive action on the nerve fibers at the point where they reach the optic disk is probably the mechanism of the initial destructive effect on vision. If the first effects of compression were felt in the retinal circulation, then the peripheral segments of the retina logically would be the first to feel the effects of increased pressure, and this would be reflected in a different type of visual field defect. In some cases nasal depression of the visual field precedes the appearance of the arcuate scotomas.

Indications for Surgical Intervention in Cases of Glaucoma: How Long Should Medical Treatment Be Continued? PROF. HILTON ROCHA, Bello Horizonte, Brazil.

In cases of chronic simple glaucoma medical treatment needs surgical supplementation from the moment it becomes evident that the disease is progressing in spite of the therapy. Hypertension is only one element in the glaucomatous syndrome; although operation may alleviate the hypertensive state, it should not be entirely separated from the supplementary medical treatment.

Chronic congestive glaucoma, more than the simple type, requires surgical intervention as a weapon against hypertension. In cases of acute glaucoma, if the attack does not yield after twenty-four hours of medical treatment, operation is necessary.

In cases of the so-called inflammatory type of secondary glaucoma, mydriatics should be used, and the response to medical treatment is generally favorable.

In cases of hydrophthalmia early operation is necessary, before physiologic structures are altered.

Indications for Surgical Treatment of Glaucoma. DR. SANTIAGO BARRENECHEA, Santiago, Chile.

The author cited cases in which the disease was adequately controlled by medical treatment over a period of years. So long as the hypertension can be regularly controlled there is no need of surgical intervention. If medical treatment fails to control the hypertension, operation should be performed even though the evolution of the disease seems far advanced.

Indications for Surgical Treatment of Chronic Glaucoma and Choice of Operative Technic. PROF. E. VELTER, Paris.

So long as the symptoms of glaucoma are controlled with miotics and there are no progressive defects in the visual field, surgical intervention may be postponed. The presence of Bjerrum's scotoma is not a contraindication to operation. Even though the fixation point is threatened by progressive narrowing of the visual field, operation should not be deferred, for loss of the central island of vision as the result of operation is rare. The author considers the fistulizing operations the best method in treatment of chronic glaucoma.

Hemicyclodialysis for Reestablishment of the Physiologic Formation of the Intraocular Fluids. Dr. Antonio Torres Estrada, México, D. F., Mexico.

The author asserted that the results obtained with cyclodialysis and hemicyclodialysis are superior to the fistulizing operations. The principal effect of hemicyclodialysis is to reestablish drainage of the aqueous through Schlemm's canal.

Gonioscopy After Lagrange's Operation. Dr. Jorge Peyret, Buenos Aires, Argentina.

The author described the usefulness of gonioscopy in the postoperative control of glaucoma after the Lagrange operation.

Induced Double Retinal Pulse as Observed in Moving Pictures: Sign of Preglaucoma (?). Dr. J. Lijo Pavía, Buenos Aires, Argentina.

Pulsation in the central retinal artery produced with the ophthalmodynamometer and persistence of pulsation in the central retinal vein constitute a double retinal pulse. Cinemas were produced showing this phenomenon. The existence of this sign, in the author's opinion, affords strong presumption that a latent glaucomatous state exists.

Etiologic Factors of Glaucoma in Colombia. Dr. A. Pesada and Dr. J. Díaz Guerrero, Bogotá, Colombia.

This paper was not available for abstracting.

Degenerative Glaucoma. Prof. A. Terres Estrada, México, D. F., Mexico.

This paper was not available for abstracting.

Plasmotherapy of Glaucoma. Dr. R. Rodríguez Barrios, Montevideo, Uruguay.

Basing his work on Duke-Elder's experimental studies, the author gave intravenous injections of plasma to patients with glaucoma and reported the clinical histories of a series of patients treated in this way. In most patients an effective decrease of ocular tension was obtained. Among the patients there are cases of primary glaucoma, both of the wide and of the narrow angle type, chronic or acute, as well as 2 cases of inflammatory glaucoma appearing in the course of iridocyclitis, in which a lowering of tension was obtained. In most patients the effect on tension appeared two or three hours after the plasma had been injected and continued for two or three days. In a case of chronic congestive glaucoma with acute onset of hypertension, all other therapeutic measures were useless, but tension was lowered to normal with the use of plasma and remained so for some time. Plasma has not been used in more cases of ocular hypertension because of the difficulty in obtaining it, and only 1 patient received injections of concentrated plasma. In some cases the value of the plasma proteins was studied. The possibility of obtaining an increase in the value of the plasma proteins with appropriate diets was suggested.

STRABISMUS

Surgical Treatment of Exophoria and Exotropia. Dr. George P. Guibor, Chicago.

The author presented the conclusions derived from his study of a series of cases of exophoria and exotropia resulting from defects or lesions in the medial longitudinal fasciculus (intranuclear paresis). These cases were characterized by exaggeration of the defect under conditions of fatigue, weakness of one or both medial rectus muscles, a normal near point of convergence for near range and an error of refraction which had no direct relation to the degree of the deviation. Resection of both medial rectus muscles associated with recession of one or both lateral rectus muscles gave better cosmetic and functional results than a similar operation performed in two sessions. Advancement of both medial rectus muscles and recession of a lateral rectus muscle did not produce a permanent cure of the strabismus. Advancement of both medial rectus muscles improved the divergence, but there was a recurrence.

Surgical Treatment of Concomitant Strabismus. Dr. Thomas Allen, Chicago.

The author emphasized the necessity of a careful preoperative examination. He called attention to the importance of determining the presence or absence of anomalous retinal correspondence. In cases of convergent strabismus with secondary overaction of an inferior oblique muscle recession of the inferior oblique as a supplement to the operation on the rectus muscles was suggested. He stated the opinion that extensive retrocession was more effective in correction of strabismus than complete tenotomy. He described a technic for insertional partial tenotomy, in which the tendon, but not the ligaments, were sectioned.

Surgical Treatment of Strabismus. Dr. Rene Contardo, Santiago, Chile.

The technic employed in the surgical correction of 60 cases of strabismus was described. The author utilized only one thread in suturing the tendon to its new point of insertion. He expressed the belief that this method not only permitted more rapid execution of the operation but added to the certainty of correction.

Operative Technic for Concomitant Strabismus. Dr. Edmundo Semeraro, Barbacena, Minas Geraes, Brazil.

In the procedure of retrocession, a large portion of Tenon's capsule is displaced backward, along with the muscle tendon, to the new insertion. In the advancement procedure on the opposite side triangular flaps of capsule are resected up to the limbus. The muscle tendon is then reattached to the sclera 3 mm. from the limbus.

Orthofusor, Amblyoscope and Prisms Indispensable in Treatment of Strabismus. Dr. J. Lijo Pavía, Buenos Aires, Argentina.

The author emphasized the role of orthopedic training in the treatment of strabismus. He described the orthofusor and the amblyoscope

and explained their function. Fourteen cases of strabismus were presented in which orthoptic training effected a correction. In some of these cases correction was obtained in four months, whereas in the more difficult cases of strabismus correction was not obtained unless orthoptic exercises were given over a two to three year period.

RESEARCH PAPERS

Filamentous Keratitis. PROF. CARLOS WESKAMP, Rosario, Argentina.

This paper was not available for abstracting.

Recent Additions to Knowledge of Experimental Nephrogenous Arterial Hypertension and Ocular Lesions. DR. FREDERICO F. K. CRAMER and DR. MIGUEL ANGEL ETCHEVERRY, Buenos Aires, Argentina.

Using Goldblatt's procedure (closure of the renal artery with forceps), the authors produced arterial hypertension in dogs and rats. They concluded that the mechanical effect of the elevated arterial pressure was chiefly responsible for the disturbances that they noted ophthalmoscopically. The prolonged action of the experimental nephrogenous increase in tension in these animals caused ocular disturbances of a vascular origin, such as distinct degrees of vascular sclerosis, hemorrhages and exudates, with impairment of renal function of variable degrees and lesions of renal sclerosis.

Nonvisual Functions of the Retina. PROF. CLEMENTE ESTABLE, Montevideo, Uruguay.

A critical survey was made of the retinohypothalamic connections and of the centers and tracts through which the retinoadrenal, retinocutaneous, retinogonadal, retinopostural and retinokinetic reflexes are produced. The author described the experiments and microscopic studies which were carried out.

Images of Secretory Elaboration of the Ciliary Epithelium. DR. J. SVERDLICK, Buenos Aires, Argentina.

With the aid of the staining method of Achucarro and del Rio Hortega, the author was able to demonstrate a granular content at the distal pole of the clear cells in the superficial stratum of the ciliary processes. It was felt that these granules play a definite secretory role in elaboration of certain organic components of the aqueous humor.

Chronaxia of the Extraocular Muscles. DR. WASHINGTON ISOLA. Montevideo, Uruguay.

Chronaximetric investigations were carried out on the extraocular muscles of dogs and rabbits. The author found that different chronaxias existed for the different muscles. For certain muscles double or triple chronaxias existed. On the basis of this work, the extraocular muscles were classified as flexor and extensor.

Circulatory Mechanism of the Iris. Prof. Clemente Estable and Prof. R. Rodríguez Barrios, Montevideo, Uruguay.

The circulatory mechanism of the iris was studied microscopically and in vivo in albino animals. The authors concluded that vasodilatation tends to produce miosis, and vice versa, and that vasoconstriction facilitates mydriasis, and vice versa. The slightest oscillation of the intraocular pressure influenced the circulation of blood in the iris. Subconjunctival injections of any solution produced mechanical effects on the circulation of blood in iris tissue independent of the action of the solution. The circulatory disturbance produced by iridectomy, paracentesis, prolapse of the iris and numerous drugs were studied.

Adrenergic Innervation of the Smooth Musculature of the Lower Eyelid. Dr. Z. M. Bacq and Dr. Washington Isola, Montevideo, Uruguay.

The contraction of smooth palpebral muscles was studied in dogs and cats. In this work new proofs of the theory of chemical transmission of nerve impulses were offered. On the basis of this theory, the behavior of smooth muscle in the eyelids in certain clinical syndromes accompanied with an increase in sympathetic tone was explained.

Interpretation of Kolmer's Rods in the Nerve Cells of the Retina. Dr. J. Sverdlick, Buenos Aires, Argentina.

By application of special stains, the author studied Kolmer's rods in the human retina. He found these rods to be present in almost all the cells of the internal granular layer.

UNOFFICIAL PAPERS

Ocular Tuberculosis and Tuberculin Therapy: Part of a Clinical Investigation (1927-1945). Prof. Carlos Charlin, Santiago, Chile.

The author called attention to the frequent occurrence of idiopathic ocular disorders in tuberculin-sensitive persons with an antecedent history of tuberculosis in the family. A comprehensive review of the literature on this subject was made. He called attention to the success of tuberculin therapy for these ocular disorders, as employed by him and by other investigators.

Pathologic and Therapeutic Aspects of Retinal Detachment. Dr. H. Arruga, Barcelona, Spain.

A review of the pathologic and therapeutic aspects of retinal detachment was presented. According to the author, the fundamental concepts of retinal detachment as proposed by Gonin have been modified very little through a period of years. From an etiologic standpoint, the retina probably does not become detached unless it is diseased. Trauma of the eye as a factor in detachment probably does not have as much importance as was at first thought. Excessive stooping, sneezing and coughing are probably important factors in producing detachments in myopic persons and in patients recovering from cataract operations. The author stated the belief that a healthy choroid is the chief factor in the

cure of detachment and, for that reason, advised minimal operative trauma to this tissue. He recommended adequate rest in bed both before and after operation. He utilizes injection of air into the vitreous as a means of maintaining tension within the eye after the surgical procedure.

Venous Thrombosis and Recurrent Vitreous Hemorrhages. PROF. E. VELTER and PROF. A. G. RENARD, Paris.

The authors pointed out that newly formed venous collaterals, after partial venous thrombosis, are very fragile. Bleeding from these newly formed venules is probably responsible for the recurrent hemorrhages observed in the retina and vitreous after periphlebitis. According to the authors, in most cases of periphlebitis of the retinal veins in young persons the condition is progressive and is nearly always due to tuberculosis. The various therapies advocated for this disease have been unsatisfactory.

The Accommodative Unit in Corrected Ametropias. DR. JOSEPH I. PASCAL, New York.

A person whose ametropia is corrected by lenses is said to have "lens emmetropia," although his condition is somewhat different from that of a person with natural emmetropia. The accommodation of the subject with natural emmetropia corresponds exactly to the dioptric power of the distances of fixation, and the accommodation of the subject with corrected ametropia also corresponds to the dioptric value of the distances, although expressed in terms of its own basic unit of accommodation.

Each person with corrected ametropia has his own accommodative unit, the value of which depends on the class and degree of his ametropia and on the distance of the corrective lens from the eye. The accommodative unit of the person with natural emmetropia is 1 D.; that of a subject with corrected hypermetropia is always more than 1 D., and that of a subject with corrected myopia is less than 1 D. For example, a subject with 5 D. of hypermetropia with his correcting lens at a distance of 15 mm. from his eye would have an accommodative unit of 1.17 D. A subject with 5 D. of myopia with his corrective lens at the same distance would have an accommodative unit of 0.865 D. In order to focus at 0.25 meter, each subject would have to use 4 units of accommodation, which represents 4.68 D. for the hypermetropic subject and 3.46 D. for the myopic subject.

The standard formula for the accommodative unit is

$$U = \frac{1}{(1-dL)} \quad (1)$$

which can be simplified as follows:

$$U = 1 - 2\ dL \quad (2)$$

The increase in the accommodative unit for the various refractions shows an interesting curve, in the shape of a parabola, with a sharp and rapid ascent for corrected hypermetropia and a slow and gradual descent for myopia.

The Replacement Lens and the Accommodative Unit.—All or part of the accommodation can be replaced by a positive lens. The degree of this lens can be calculated in exactly the same way for the subject with natural emmetropia as for the subject with "lens emmetropia," so long as the accommodation can be calculated in corresponding accommodative units. The formula for the replacement lens is

$$L' = \frac{A}{L \cdot dA} \quad (3)$$

in which A is accommodation, expressed in accommodative units. When this is expressed in diopters, the formula for the replacement lens is as follows:

$$L' = \frac{A}{U \cdot dA} \quad (4)$$

The degree of the replacement lens depends not only on the class and degree of the ametropia and the position of the corrective lens but also on the stage of the accommodative process in which the diopter or the accommodative unit should be replaced. For example, a stronger lens is needed to replace the second unit of accommodation than that necessary for the first; and lenses of higher degrees, for the third, fourth and fifth units of accommodation, and so on. The graph for replacement lenses is in the form of a section of a parabola, showing the increasing degrees for the different stages of the process.

The replacement lens, therefore, has an efficiency related to the accommodation, which depends on whether the lens is equal, greater or smaller than the accommodation it replaces. In cases of natural emmetropia and corrected myopia the replacement lens has a negative efficiency, because it has a greater dioptric power than the accommodation it replaces. In cases of corrected hypermetropia the replacement lens has a positive efficiency inasmuch as it replaces that part of the accommodation which should be used to neutralize the hypermetropia totally or partially; its efficiency is negative when it replaces accommodation above this level.

This concept of the accommodative unit clearly explains why, from the optical standpoint, the subject with corrected hypermetropia becomes presbyopic earlier than the subject with corrected myopia; it also explains why in cases of anisometropia, because of the different accommodative units for the two eyes, it is wisest to prescribe a stronger lens for reading for the eye with the least intrinsic power of refraction; and why in cases of astigmatism, although properly corrected, a perfect focus for near vision cannot be obtained, owing to the different accommodative unit for each meridian.

History of Ophthalmology in Latin America. Dr. Moacyr E. Alvaro, São Paulo, Brazil.

The author traced the origin and trends of ophthalmology in the various Latin American countries. Most of the chairs of ophthalmology in the South American countries were established in the period from 1875 to 1890 by European-trained ophthalmologists. In more recent years, the European influence on ophthalmologic thought has been less noticeable in South American countries because students have

remained at home for postgraduate study. In Mexico, Cuba and the Central American countries most of the younger ophthalmologists are American trained.

Damel's Technic for Correction of Generally Contracted Orbital Socket. Prof. R. Laje Weskamp, Córdoba, Argentina.

Damel's operation for restoration of the conjunctival cul-de-sac is destined for cases in which the loss of the inferior fornix makes the cavity incapable of retaining an artificial eye. A horizontal incision is made parallel to and 6 mm. from the inferior lid border. The conjunctiva is undermined backward and is freed from all adhesions. A new cul-de-sac is then made by stitching the mobile conjunctiva to the deep surface of the skin near the orbital floor.

Extraction of Foreign Bodies with Aid of the Slit Lamp. Dr. A. Posada, Bogotá, Colombia.

This paper was not available for abstracting.

A New Operative Technic of Conjunctival Grafting in the Pterygium. Dr. Roque Bellido Tagle, Lima, Peru.

The apex of the pterygium is peeled from the cornea in the usual manner, but the body of the pterygium is resected, leaving a semilunar defect extending from the limbus to the caruncle. The defect is covered by a graft obtained from the conjunctival tissue along the superior limbus and anchored with suitable sutures. The donor area is closed with a running stitch.

Onchocerciasis in Guatemala. Dr. E. Pacheco Luna, Guatemala, Guatemala.

Onchocerciasis is endemic in certain limited areas of Guatemala and is responsible for a high percentage of blindness among persons working on coffee plantations. A species of fly is the intermediate host, and the disease is transmitted from one human host to another by the bite of this fly. The filariae have a predilection for the subcutaneous tissue of the head and form fibrous tumors as they reproduce. The microfilariae may infect any of the tissues of the eye. With repeated infections of the eye chronic keratitis or progressive uveitis develops, ultimately leading to phthisis bulbi. Except for excision of the fibrous tumors, there has been no satisfactory treatment.

Intracapsular Cataract Operations. Dr. Manuel Anton Pérez, Habana, Cuba.

A series of 250 intracapsular cataract extractions was reviewed. The author extracted the cataracts with a Sinclair forceps and Arruga hook. In all but 10 cases some type of iridectomy was performed. The corneal incision was made with the Graefe knife, and Liégard's corneoscleral suture was inserted.

Ocular Alterations Associated with Leprosy. Dr. Siqueira de Carvalho, Rio de Janeiro, Brazil.

This paper was not available for abstracting.

Actual Conditions in the Onchocerciasis Clinic. Dr. M. Puig Solanes, México, D. F., Mexico.

This paper was not available for abstracting.

Alterations in Detached Retina as Observed by Stereoscopic Ophthalmoscopy. Prof. Archimede Busacca, São Paulo, Brazil.

Stereoscopic ophthalmoscopy facilitates the diagnosis of minute retinal detachments because it is possible to visualize the separation of the retina from the underlying pigment epithelium. The changes noted with detachments at the fovea and the perifoveal region were described.

Pseudotumoral Exophthalmos. Prof. E. Velter and Dr. Guy Offret, Paris.

The authors called attention to cases of progressive exophthalmos, either unilateral or bilateral, in which surgical exploration failed to demonstrate the presence of an intraorbital tumor. Histologic examination in these cases revealed a true increase in the volume of the extraocular muscles. The role of the endocrine glands, particularly the thyroid, and the possibility of intraorbital phlebitis as etiologic agents in this type of exophthalmos were discussed.

Keratoconus in Colombia. Dr. J. Díaz Guerrero, Bogotá, Colombia.

This paper was not available for abstracting.

Microphakia Associated with Secondary Glaucoma. Dr. J. Martins Rocha, Campinas, Brazil.

This paper was not available for abstracting.

Relation of Avitaminosis A to Infantile Blindness. Dr. J. Tavares, Rio de Janeiro, Brazil.

This paper was not available for abstracting.

Visualization of the Choroidal Vessels with del Río-Hortega's Silver Impregnation. Dr. J. Sverdlick, Buenos Aires, Argentina.

The vascular network of the human choroid was studied with the silver impregnation stain of del Río-Hortega. Anastomosis of the venous channels was described.

Difficulties in Clinical Interpretation of Syndromes of Compression of the Intracranial Portion of the Optic Nerve. Prof. E. Velter and Dr. Desvignes, Paris.

The authors mentioned numerous clinical conditions that can, directly or indirectly, produce compression on the intracranial portion of the optic nerve. They emphasized that a careful neurologic examination must be made and careful attention directed to the clinical evolution of the signs and symptoms if mistakes in diagnosis were to be avoided.

Cataract Operation with a Security Knot. Dr. A. Posada and Dr. J. Díaz Guerrero, Bogotá, Colombia.

This paper was not available for abstracting.

Relation of Ocular Tension, Arterial Tension, Venous Pressure and Rate of Circulation. Dr. M. Puig Solanes, México, D. F., Mexico.

This paper was not available for abstracting.

Local Use of Penicillin in Ophthalmology. Dr. E. Salerno, São Paulo, Brazil.

The author cited 2 cases of intraocular infection and 1 case of external infection in which penicillin had been successfully employed. For intramuscular use, a dose of 10,000 units given every three hours day and night was recommended.

Book Reviews

Les yeux et la vision des verébrés. By A. Rochon-Duvigneaud. Pp. 719, with 500 illustrations. Paris: Masson & Cie, 1943.

It is not often that a man has the privilege, by living long enough, of seeing his dreams come true. Rochon-Duvigneaud, now in his middle eighties, but in no way less alert than when I first knew him, over a quarter of a century ago, seems to have had this luck. He was one of the most prominent French ophthalmologists by profession, but he strikes one as having always been a zoologist and a student of comparative anatomy by taste. He retired from active duty in the Laennec Hospital, Paris, in 1926 and has spent the last fifteen years in collecting his previous papers, completing his studies of animal eyes and writing this remarkable book on the eyes and vision of the vertebrates.

Chapter 1, which contains 150 pages, gives a description of the human eye, with constant reference to similar structures in animals. Chapter 2 (30 pages) deals with the origin of the vertebrate eye. Notwithstanding well developed eyes in a few invertebrates, such as the gastropods and cephalopods, with a retina, a lens, a transparent cornea and a pigmented diaphragm, the author does not believe that the vertebrate eye can in any way have been derived from the invertebrate eye. Studies in comparative embryology show that at an early stage there is a striking similarity in the eyes of the embryos of all classes of vertebrates. Differentiation comes later.

Succeeding chapters are devoted to the description of the eyes of fishes (cyclostomes, selacians, teleosts, chondrosteans and dipnoans) batrachians, reptiles, birds and mammals. It is, of course, impossible to review this book in detail, and I can note only some of the most striking features mentioned. I have, of course, read this book as an ophthalmologist, not as a zoologist, and it was chiefly with reference to the physiology and pathology of the human eye that my interest was awakened.

Fishes.—It is usually accepted that refraction is hyperopic in selacians and myopic in teleosts, but the author finds hyperopic refraction even in the latter. There is a curious description of Anableps tetrophthalmus, with its bifocal cornea. There are two pupils in each eye, and, as this fish usually has its head half out of the water, the one is used to see through air and the other to see through water. Syngnathus acus has a pigmented layer in the cornea; the center remains clear, and this may constitute a diaphragm useful in improving vision. Ocular tension in fishes is low. There is no evidence of filtration in the angle, no canal of Schlemm.

Batrachians.—The author finds a muscular diaphragm in all arterioles supplying the uvea, particularly in the anterior segment, and he believes that this may regulate the ocular tension. There is a curious atrophic eye in Proteus anguinus. A perfectly normal embryonic eye forms in the larva; then it shrinks, and in the adult it is but a small pigmented

nodule, some 300 microns in diameter, hidden under the skin. Proteus anguinus lives in subterranean waters, away from any light. Has this anything to do with this atrophy?

Reptiles.—In the turtle, accommodation is due to the formation of an anterior lenticonus through contraction of the iris. The retina is particularly well developed in the saurian eye. Amacrine and ganglion cells are probably better represented here than in any other animals. One of the most curious features in reptiles is the fact that many of them see through a fixed and transparent lid (ophidians).

Birds.—The author has always been particularly interested in birds, and the chapter on the physiology of their vision is well worth reading. He does not believe, as many have suggested, that birds have a visual acuity much better than man's. The colored drops in the bird retina are, of course, discussed, but their true use remains unknown. The author has studied the visual field by placing the head in the center of a perimeter, baring the posterior aspect of the sclera and moving along the arc of the perimeter a small light, which is seen on the sclera. In that fashion he has studied the overlapping of the binocular field and the visual axes. This work is very interesting, as some birds of prey have a double fovea: One is central, looks laterally and is used for monocular vision; the other is peripheral, looks forward and is used for binocular vision. The eyes of most birds are aspherical; the upper half, which sees the ground as the bird is in flight, is larger than the lower half. The author points out that the horned owl has a very large canal of Schlemm (2 mm. in diameter) and that some problems of physiology concerned with ocular tension might be solved by using this animal for experimental research.

Mammals.—It is only with mammals that the movements of the two eyes are associated. In more primitive forms they are independent. Sometimes this is very evident (chameleon) because the amplitude of the independent movements is great. Another characteristic feature of the mammalian eye is that blood vessels penetrate the retina. There is a detailed description of the mole's eye, which is curiously undeveloped. With the simians, one nears man, and many human features are already evident: small cornea, well developed fovea, strong ciliary muscle, fairly parallel visual axes and convergence.

This review can give but an incomplete idea of this excellent book. There are many references at the end of each chapter, and the illustrations are superb. Although the book came out in 1943, the publishers were able to print it on perfect paper, which they had had in stock since before the war. This is fortunate, for the book would have lost a great part of its value if the 500 illustrations had come out less well.

EDWARD HARTMANN, M.D.

Fundamentals of Clinical Neurology. By H. Houston Merritt, M.D.; Fred A. Mettler, M.D., and Tracy Jackson Putnam, M.D. Price, $6. Pp. 289, with 96 illustrations. Philadelphia: The Blakiston Company, 1947.

In a small volume of 289 pages, and 96 illustrations, the reader will find an excellent introduction to clinical neurology. The subject is presented in an original manner and is discussed in two main

divisions: examination of the nervous system and the anatomic diagnosis. The first part consists of a practical description of the examination of the patient, and the second, an explanation of the anatomy and the fundamental physiology of each part. A brief description of the commonly encountered disorders is added. The illustrations are taken mostly from Mettler's excellent "Neuroanatomy"; they are well chosen and are a considerable help to the text. While treatment is only briefly discussed, there is an excellent chapter on the examination of the spinal fluid with an interpretation of the findings.

This is a thoroughly practical work which should be of great service to the general practitioner and to the ophthalmologist, who so frequently encounters neurologic problems.

ARNOLD KNAPP.

An Introduction to the Prescribing and Fitting of Contact Lenses. By Frank Dickinson and K. G. Clifford Hall. Price, £2 2s. Pp. 168, with 10 colored photographs, 55 halftone photographs and 32 diagrams. London: Hammond, Hammond & Company, Ltd., 1946.

Several books on contact lenses have appeared in this country. Of these, the most comprehensive was that by Obrig, which has already been reviewed in the ARCHIVES (**28:** 568 [Sept.] 1942). The authors of the book under review, which is the first of its kind to be printed in England, have been much influenced by Obrig's work and generously acknowledge the obligation.

All known methods of fitting contact glasses are carefully described, but the authors prefer the technic of the molded lens. For taking the impression they used "negocoll" at first, but now prefer "moldite" (made in the United States) or "zelex," a British preparation. A positive cast of dental stone is then made and sent to the lens makers, who return semifitted plastic shells. These are then modified to fit accurately.

In considering the problem of contact glasses as a whole, the authors are objective and honest. They point out that "there remains an inescapable limitation to the sphere of usefulness of contact lenses," and they warn that "all-day tolerance is rather an exceptional performance." Their recognition that among the motives actuating patients to present themselves for contact glasses "the vanity motive is perhaps the most powerful of all" is shrewd, and should be salutary. "In a sense," they say, "contact glasses are complementary to spectacles. They may be regarded simply as an alternative means for the correction of refractive errors. . . . Cases are occasionally encountered in which the non-medical practitioner would hesitate to proceed except under the guidance of an experienced ophthalmic surgeon. . . . Problems impinging on ophthalmology may properly be handled only by the ophthalmologist."

The photographs in this work are the best examples I have ever seen of the pictorial description of technic and should be studied and imitated by medical photographers in all fields. They may account for the high price of the book—more than $8 at the current rate of exchange.

G. M. BRUCE.